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ABSTRACT

A study was conducted to examine writing skill, particularly maintenance of coherence, in an environment where the information load was heavy and students would be expected to have problems organizing it. The students, all proficient in English, were enrolled in a postsecondary biology class. Two of the six students in the study had high objective test scores in the course, two had borderline and two had failing scores. Discussion and results of the study are presented in three parts. The first of these is a descriptive case study of two students whose learning of biology information got in the way of their coherence in writing. Under pressure to be relevant to the lead-in sentence assigned, the students began producing prose which, although clumsy, was shaped to follow logically from the lead in sentence. The new structure, termed here "predication load," carried more information and more types of information than their previous structure. In a second part, samples of six students' work were analyzed for predication load in order to compare essays written two months apart. The high predication load brought with it the possibility of increased errors and awkwardly constructed sentences. The final section explores the implications of the study, especially the hypothesis that predication load in writing is a function of the task. (AMH)

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Papers in Applied Linguistics

COMPOSING AND COHERENCE

The Writing of Eleven Pre-Medical Students

Suzanne E. Jacobs

U.S. DEPARTMENT OF EDUCATION
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PROLOGUE AND SUMMARY

The second lecture on muscles is nearly finished. I lean forward in a wooden chair, trying to watch the professor graph an action potential and copy it into my notes at the same time. This is the first biology course I've observed in 20 years. Ordinarily I teach writing.

The room is brightly lit, and the professor speaks fast, now drawing graphs, now pointing to the slide projected on the screen, now speaking straight to the group, hands resting in the pockets of her lab coat. The eyes of 11 students are serious and intense; like mine, they go back and forth from blackboard to notebook. A hand is raised; a question answered.

There are three kinds of muscles, she tells us. Skeletal muscles are striated. Notice the striped appearance of a cell under the microscope. The Krebs cycle has several steps. The body generates ATP in a number of ways. Four types of protein. Filaments, thick and thin. Permeability. Salts flow through the cell wall, faster, faster, more and more. The line of the action potential goes higher and higher. The filaments have interacted. Notice the stripes are now narrower, denser, darker. Contraction has occurred. Class is finished.

As she winds the cord of the slide projector, the professor answers more questions for the few students who have remained in the room. "Form and function," she says. "Just try to keep in mind how form relates to function."

The next afternoon the same 11 students are seated at the long black tables in the laboratory for the weekly writing exercise. All of them have begun with the sentence composed by the professor and assigned by me:

Muscle cells are cells specialized for contraction.

And now they are trying to decide how to follow the instruction to keep on writing so as to follow up on this sentence in a way that sounds natural. The lead-in sentence sets the classic topic of form and function; they will have to say how the specialized equipment of the muscle cell allows it to contract. But they know so much about filaments, proteins, ATP, and the Krebs cycle that they hardly know where to start. Which information should they select? Which should they leave out? How should they phrase it?

Each week in the course of the semester I will give a similar task, watching closely the way the student writers handle their biology information. As someone concerned with instruction in writing, I want to watch the interaction between the students, the material, and the prose that is produced.

† † †

The students wrote 12 of these essays. Each week I corrected them in the fashion common to most composition classes, putting right grammatical errors and adding general comments in the margins and at the end. In the process I stressed three criteria: relevance to the lead-in sentence, quantity of detail, and correctness of the language. I returned these essays to the student's mailbox, together with a successful sample essay and a dittoed message containing my general remarks about the progress of the class and showing the range of grades.

The purpose of the study was to examine writing skill outside the composition class in an environment where the information load was heavy and students would be expected to have problems organizing it. All the students had access to the same information, and the basics of grammar were familiar to all of them, most of whom were seniors in college. Half of the group were non-native speakers of English, but even they were proficient in English grammar, or nearly so.

Aside from the written corrections and comments described above and some conversation between the students and me, I did no direct teaching of writing skills. My purpose was not to test a teaching method but to examine the skill (or lack of it) shown by the students and to describe whatever changes might occur in their writing over the course of the semester.

My purpose in particular was to look at the way the student writers maintained coherence, or prevented the reader from feeling bumps or total breaks in the flow of information. To make their writing a connected piece of text, coherent writers presumably do more than provide such connective phrases as "therefore" and referring words like pronouns. At some stage in the composing process writers must select and mentally arrange information that somehow belongs together. A preliminary objective of the study was to discover ways of examining written prose so as to shed light on this part of the composing process.

In the past, scholars have suggested various ways of analyzing discourse, each suited to a different purpose. Those who teach composition are generally familiar with literary scholarship; they think in terms of genre and the relation of genre to the writer and reader. Where scholars in this tradition have done close textual analysis related to student writing, they have shown rhetorical connections such as cause/effect, comparison/contrast, and so forth. The value of this work is its emphasis on language beyond the level of the sentence and the relation of this language to the problems that writers have in making their raw information serve the purpose they want it to serve. With a few exceptions, however, this kind of text analysis has not been related to sentence syntax. And in spite of the fact that scholars doing this work are interested in the teaching of composition, there has been little interest in the text analysis of bad or incoherent prose. The differences between good and bad, coherent and incoherent, have not been studied in much detail (Mina Shaughnessy is an obvious exception). What faulty prose indicates in regard to a writer's developing sense of discourse structure has been a matter of guesswork.

Until recently linguists have not tried to answer the important questions about semantic connectedness with which rhetoricians have been concerned. But they have made the analysis of errors a productive mechanism, pairing wrong sentences with corresponding right sentences and then isolating and describing the features that account for the errors. On this and other points, linguistic science has lessons to offer to those doing analysis in the structure of tests. So, too, do psychologists who have devised ways of analyzing text for purposes of study in memory and reading comprehension.

In the chapters that follow, the results of the present study are presented in three parts. The first of these (Chapter 3) is a descriptive case study of two students whose learning of biology information got in the way of their coherence in writing. They brought to the page whole passages of information straight from the lecture or textbook. These unmodified chunks had a structure of their own, but the structure was not appropriate for the writing task, for much of the information was not relevant to the lead-in sentences. Under pressure to be relevant at all costs, the students began producing prose with a new and different structure, one that they themselves imposed on the information. The new prose, though it was inclined to be clumsy, hard to read, and grammatically faulty, was shaped to follow logically from the lead-in sentence. In the

course of the semester the prose produced by these students see-sawed between the two kinds of structure.

What, then, was the nature of the new structure, and how did it contrast with the old? The new one contained what is termed here a higher "predication load" than the old, because each sentence carried more information. Not only did the sentences carry more information but more **types** of information as well (see Chapter 5).

The basis for this analysis was a distinction between two kinds of predication. "This is an example" and "This is an apple" are both predications, but predications with different functions: the first has a linking function that the second lacks. The first was termed a "relational" predication, the second a "content" predication. A second kind of distinction—also important, but less so—was the distinction between content predications that described states or static conditions and those which described movement, change, or activity. In the biology lectures and textbooks, static information was typically given first, as introductory material, and dynamic information second. Students sometimes tended in their writing to separate these two kinds of content information.

Samples of six students' work were analyzed for predication load in order to compare essays written two months apart. The analysis was done for two students whose scores on objective tests for the course were consistently high, two whose scores were failing, and two whose scores were consistently on the borderline. Those students on the borderline—called here the "middle group"—included the two who began to use the new structure when they perceived the demand for relevance. As anticipated, the work of the high and low groups was fairly consistent in predication load, while the two from the middle group showed a considerable rise on the second sample. For the two from the middle group, the first essay showed measures of predication load that were too low. That is, there was insufficient integration of information types; the student, in composing each sentence, had brought together too few predications. The result was insufficiently complex to give readers the kind and combination of information they expected.

I found that sentences with high predication load—that is, a high degree of integration of types—were frequently flawed by grammatical errors (see Chapter 6). Some students, of course, made fewer errors than others, but every writer who had managed to include the relational information necessary for maintaining coherence had also made at least some errors in forming sentences. Moreover, there was a greater tendency towards error when the form of the sentence was relational, that is, when the relational predication became the main predication of the surface sentence. The following sentence (a correct one) uses the relational form, the main predication being "An example is . . ."

An example of chemical barriers is the action of acids in the stomach.

When the relational meaning was written in the reduced form, "for example," the sentence was easier for the writer to handle gracefully:

Acids in the stomach, for example, act as chemical barriers.

Thus, for the subjects of this study the high predication load, necessary to meet the demands of the assignment and to prevent the writing from becoming incoherent, brought with it the opportunity for making increased errors or producing awkwardly constructed sentences.

In Chapter 7 I explore the implications of the study, especially the hypothesis that predication load in writing is a function of the task, whether the task is given by a teacher or imposed by the writer on himself. Where the task asks for general ideas to be stated early in the piece of writing, the writer take on the responsibility of keeping the reader informed about the relationship between these general ideas and the other

material he has to offer. Thus he has the responsibility of providing relational statements. Where the task does not demand generalizations first, the writer may be able to employ forms that do not require this mix of content and relational predications. The coherence of these forms depends on different kinds of structuring, such as parallelism and chronological ordering.

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CHAPTER 1

Writing for School and College: The Context and Purpose of the Study

A common complaint of college English instructors is that many students produce correct writing only when the assignment fits particular discourse types. For narrative the student's writing is clear, readable, and correct, but when he or she writes for an academic assignment, the writing becomes confused, tangled, and sometimes incomprehensible. Or, if not tangled, the prose may simply take off in a direction of its own, becoming what Linda Flower (1979) refers to as "writer-based" writing. That is, while the structure of the prose helps the writer recall information, it does not give the readers what they expect. In the few contrastive studies that Mina Shaughnessy did of skilled and unskilled college writers doing the same assignment, she noted that skilled writers possessed "hidden features of competency."[1] These features, she said, had to do not with drawing conclusions but with putting together sentences that would convincingly support these conclusions. In the writing of the unskilled, the information was there, but its relation to the writer's point was unclear.

What we are concerned with here is coherence. The object of the study is to describe coherence in such a way as to shed light on the way writers mold and combine information—or fail to do so—in the ways described above. For most of us the concept of coherence is vague, and the words we commonly use to describe it are equally vague. Perhaps the most reliable indicators of coherence are descriptions of reader response. In this sense, a piece of writing is coherent when it elicits the response: "I follow you. I see what you mean." It is incoherent when it elicits the response: "I see what you're saying here, but what has this got to do with the topic at hand or with what you just told me above?" The difference between the two responses has to do with the connections, either implied or stated, between an earlier and later sentence, but what these connections are and how they are established by student writers is not at all clear.

If students, working with the facts from a biology lecture, have been able to pull together various pieces of information so that their relationships are clear, then we want to say how they have used language to do this. And if they have not succeeded in doing so, we want to be able to point to the feature of language that was missing or abused, or the rule that was broken. We need to know whether the process of relating information has any connection at all with so-called basic grammatical errors, or whether language correctness and language coherence are unrelated. In general, we need a conceptual apparatus to help explain the special writing problems students have when they try to write for a subject-matter class and to predict what progress can be expected toward more coherent writing in this context.

Too many investigations have begun from the premiss that everyone knows what writing is and that what is needed is knowledge about how to teach it. This study starts from the assumption that not enough is known about the information structure of the

written text itself. The study is meant to address the need for knowledge about the written product so that future investigators can be somewhat more sure than they are now about the kind of writing they have when they have it. The need for constructs is crucial. As one writer has put it, "Researchers can hardly claim that their techniques have 'construct validity' in the absence of a construct."[2]

The details of the study itself are provided in Chapters 2, 3, 5, and 6, with a review of the scholarly terminology presented in Chapter 4. The remainder of this chapter explores two general issues important to the context of the investigation.

Issue One: There Is No Single Style of Good Writing

Let us consider, first of all, the type of writing assignment under investigation for the present study and the discourse style it required.

Students were asked to write examination-style prose. A set proposition was given them, a set amount of time, and a set amount of paper. Their task was to elaborate on, or to discuss, the proposition. It was presumed that they knew the tacit rules of examination prose: that digression is not allowed, that reference to self or to personal experience is not appropriate, and that language is to be linear and logical. It was also presumed that they knew what it meant to "support" the set proposition, using as raw data the facts and information provided by the course. A further presumption was that they knew that introductions are excessive in examination prose, even frivolous, since the reader of the essay, i.e. the professor of the course, needs no orientation to the nature of the material.

Such a discourse type stands in sharp contrast to other types, as suggested by the display of various kinds of writing in Table 1. Rules and constraints differ considerably, depending on the type of writing. Advertising copy, though occasionally more literary than the sample in Table 1, Item 1, does not demand grammatically complete sentences, tight inter-sentence logic, or graceful parallels of structure. The choppy sentences in Item 1 can be read in almost any order. Message is all. Read it. Get it. The quicker the better.

The style of Item 2 stands at the opposite extreme, showing a serious tone, a technical vocabulary, and a complicated logic that connects not only the various pieces of this sentence in an if-then structure, but connects the sentence as well with a sentence that came before it. The topic is not what happened yesterday, nor how people feel, nor what the writer did yesterday, nor what he feels; the topic is general truth. Narrative is not appropriate, nor does the reader expect to hear about the writer.

The style of Items 3 and 4 is easier-going, less formal than that of Item 2, because the persona of the writer comes naturally to the surface. The writer in Item 3 addresses a specific reader, in what Martin Joos (1954) might call a consultative style. The writer wants to know what this reader thinks; he expects an answer. The writer in Item 4, while expecting no answer, nevertheless talks to his readers as though they were there. Narrative is the mode, and the author is part of the subject matter.

Items 5 and 6 show signs of being academic in style. The word "aspect" is a clue, suggesting that the main topic is abstract, as "conflicts" or "styles" are abstract. Though one could write a hundred years ago of a man's "aspect," the word no longer has this concrete meaning. "Fourth and final" is a conventional signpost for readers of academic prose. In Item 6 the structure of the paragraph is also identifiably academic. Is it not obvious how the writer would continue from the point where the prose is cut off? And who but an academic writer, writing for an academic audience, would say, "It is the purpose of this paper to . . ."

Table 1

The Variety of Writing Types

Item 1:	**Advertising Copy**	Mini models. An enchanting experience. For little people with big ideas. Ages to 11. Exclusively Barbizon. Carefully designed to polish the apple of your eye.
Item 2:	**Science Writing**	Then if H is fixed and the mass, m, of the particle is fixed, one can from (3) deduce the angular frequency of the oscillator (which is equal to 2 pi times the number of cycles per second).
Item 3:	**Business Communication**	I wonder what you think about the advisability of continuing this line of merchandise. Sales have dropped slightly but strength remains in the over-40 market.
Item 4:	**General Exposition, Experience-Based**	I have spent a good deal of my time patching up the children who have been wounded by people who gave them fear. Fear can be a terrible thing in a child's life. (A.S. Neill, **Summerhill**.)
Item 5:	**Academic Writing**	A fourth and final aspect of the assignment variable is the examination situation.
Item 6:	**Academic Writing**	Civil wars have plagued the development of civilization around the world and throughout history, from ancient China to modern day Spain and Vietnam. The countries of Western Europe have been especially troubled by civil strife, stemming from both the territorial ambitions of popes and landlords and the rebellious desperation of the poor. It is the purpose of this paper to explore the causes of . . .

It is important to point out this considerable range in styles of written language. There is a fairly widespread belief, even in the English-teaching profession, that there is a single style of "good writing." Call this belief the monolithic view, or what you will, it is much in evidence in traditional books used by English teachers at all grade levels. Cooper et al. (1978), for example, point to just one of these books:

> According to Warriner's **English Grammar and Composition**—a typical practical stylist handbook, perhaps the one most widely used in public schools—the chief problem in writing well is choosing language, syntax, and organizational patterns that are consistent with the practice of "educated people," those whose speech and writing define "good English." This practice, supposedly distinguished by such characteristics as correctness, conciseness, and clarity, is appropriate for

every situation in which one is "writing carefully." In all these situations—"serious articles, 'literary essays,' essay-type answers on examinations, research papers, and formal speeches"—a writer adopts a polite, earnest persona that is eager not to confuse or offend an audience that has assimilated the principles of standard English. By and large, the writer's chief purpose is to present information and ideas in a clear, orderly fashion to an audience that, so far as we can determine, has no emotional investment in either the writer of the piece or in the subject being discussed. In judging writing, Warriner makes the assumption that the qualities of "good" writing remain essentially the same, no matter what the mode or purpose of the writing.

The writing style under investigation in this study is, in fact, the careful, earnest, formal, and linear style just referred to, but it is merely a variety of written English and not generalized "good writing." Those students who have not mastered its forms may demonstrate skill in other discourse types. They may also be skilled speakers. Problems in writing represent the natural awkwardness of a learner working in an unfamiliar medium rather than a general inability to think clearly or communicate effectively. It should hardly be surprising that a sizable chunk of the population may not be able to produce on demand particular discourse types, either because they are ignorant of the rules or because they know the rules but cannot produce in accordance with them.

Issue Two: Writing Brings Learning

Now let us consider the cognitive aspect of writing—the thinking that comes with the writing act and the way that writing may help the learner cope with unfamiliar information.

In point of fact, the general discussion of schoolroom writing both in the press and in educational circles pays little attention to this aspect of writing, perhaps because writing as a task is too narrowly conceived. Professional writers are believed to do "real writing," but what students do when they write in school is spell or practice their penmanship. Even in the view of many writing teachers, the cognitive activity that goes with writing is limited to the organization of ideas. As for what is learned from the activity of writing, the view is equally narrow: what is learned is writing skill.

There is little recognition of the fact that students writing in school are engaged in a process that is psychologically and verbally complex, demanding and developing the powers of imagination and problem-solving. Not only must young writers develop a certain fluency—and sometimes the importance of sheer fluency is overlooked—but they also have to sustain the stream of words, to keep the flow from drying up, in the face of an intimidating silence on the part of their audience.

By way of example, let's take just one task and one age group. Suppose that a class of 12-year-olds has read the journal of Lewis and Clark. They are then asked to write a narrative account of one short part of the journal, selecting the part they found interesting and expanding it to form the basis for a movie. The writers will need to imagine the physical scene, imagine a series of actions that match up with their judgements of the characters and events recorded in the journal, and make their imagination work within the constraints of what they conceive narrative to be. They will perhaps impose motifs from "Little House on the Prairie," cowboy films, or even shipwreck and survival stories. They may alternatively see the journey as a scientific expedition, like Darwin's, or a long camping trip. Whatever the exact process, it is clear that the words in the journal will not be the only source for the writing; these words will be bounced against other constructs already in the repertoire of the writers.

In the process of writing, the 12-year-olds will transform part of the Lewis and Clark journal. But the thinking that goes on in the process can be described not as a distortion of the truth but rather as a process of assimilation. The words on the page are made to interact with whatever the writer has read, felt, or seen. To be sure, the narra-

tive accounts may ignore or change the original journal, but to reproduce what really happened is impossible. Even news reporters use their stock of ready-made concepts to impose meaning or significance on the events they write about. Whether limited or not, the young writer's stock of concepts is what he or she has to work with.

The worrisome thing is that so much in-school writing makes no use of the student's conceptual repertoire. The function of writing, beyond instruction in spelling and the learning of writing skills themselves, is thought by many to be record-keeping, pure and simple, especially in classes other than English. James Britton and his team of investigators examined 2,000 pieces of student writing collected from all across the curriculum of British secondary schools. They were dismayed at the relatively large number of pieces apparently copied straight from books and blackboards.[3] As the students wrote these pieces, many of them biographical or factual pieces about topics such as inventions, they transformed neither the ordering of information, nor the voice, nor the point of view. It might be argued that such writing preserves the qualities of the original; students were no doubt encouraged to use passages written by others on the assumption that the act of reproducing them would lead to mastery of the knowledge in them.

But as the Bullock Report[4] points out, such a view confuses the knower with the known:

> It is a confusion of everyday thought that we tend to regard "knowledge" as something that exists independently of someone who knows. "What is known" must in fact be brought to life afresh in every "knower" by his own efforts . . . In order to accept what is offered when we are told something, we have to have somewhere to put it; and having somewhere to put it means that the framework of past knowledge and experience into which it must fit is adequate as a means of interpreting and apprehending it. Something approximating to finding out for ourselves needs therefore to take place if we are to be successfully told.

One implication of the Britton research is that in-school writing which encourages writers to find new forms for information provides them with an effective way to assimilate such information within the framework of their prior knowledge. The Britton team found a form they refer to as the "expressive" mode—a style of writing close to talking—especially useful, but it is also clear from their examples that any change from one form to another produced the thinking activity they believed to be desirable.

Why, then, don't teachers assign more such writing tasks in school? For one thing, it is not obvious why a change of form should induce conceptual thinking. Also, the nature of conceptual thinking is not well understood. And finally, knowledge is still widely conceived of in the way that Bullock describes above: as a product with an independent and unchanging existence.

It is not only the public that has an oversimplified conception of the role of in-school writing. Influential theorists have also oversimplified the function of such tasks. Twentieth-century learning theory has had the effect, perhaps not intended by its originators, of sweeping out valuable educational ideas inherited from the 19th century, as well as much modern common sense.

One voice of modern common sense is that of Vygotsky, whose work with conceptual language in learning is well known.[5] What we have done, he suggests, is ignore the transfer effects of one kind of learning into another. In particular, we have ignored the influence of sharpened language skills. It is clear from his empirical studies of children's language that he is not writing about the use of correct forms so much as the use of language to generalize, specify, evaluate, and generally make sense of a complex world. The development of language concepts is crucial, even for the ability to learn arithmetic.

The tendency of educators to discredit this carryover process, he implies, is due in

part to the behaviorist argument that training cannot transfer. Here he refers to the work of Thorndike, whose empirical studies of transfer of training[6] were well known to him. Though Thorndike's experiments showed that learning a first task did not significantly reduce the time it took to learn a second, Vygotsky argued that these results in no way discredited the entire notion of transfer. The tasks required of Thorndike's subjects were too low-level, Vygotsky argues, to be regarded as typical of learning tasks in general. The subjects, it is true, had difficulty in transferring their skill in gauging the length of lines to gauging the size of angles. But what kind of learning is involved here? Vygotsky maintains that the results say something only about "lower-level" tasks. It stands to reason, he says, that transfer occurs only in those kinds of instruction that activate large areas of consciousness, the higher functions of "awareness," "abstraction," and "control."

Vygotsky himself is much in sympathy with Herbart (1902), who credited higher-level learning activities with a double outcome. One effect was mastery of content; the second was mental growth. To use Herbart's terminology, education in a "formal discipline" could train the "mental faculties." The consequence of learning formal disciplines was a skill in conceptualizing that readied the mind for new learning. It is unfortunate, Vygotsky claims, that in Herbart's day only Latin and Greek were considered formal disciplines. It is clear from Vygotsky's remarks about writing instruction in the mother tongue that he considers writing to be a formal discipline and thus to lead to the conceptual learning or mental growth important for learning in other areas.

Twentieth-century theories of learning, however, separate writing instruction from other kinds of learning. Vygotsky states the issue in question form:

> Does it do anything to [the learner's] memory, attention, or thinking, or does it not? Traditional psychology answers: Yes, in so far as they exercise these functions; but the process of development as such does not change; nothing new happens in the mental growth of the child; he has learned to write—that is all.

In other words, this model does not allow for the possibility that instruction in writing brings with it new mental growth. The mental growth is considered part of the so-called "development" of the writer rather than an instructional outcome. It is in place, so to speak, before the writing instruction begins. How can it be known that the mental growth has occurred prior to the instruction? Simply from the definition of "development:" learning cannot occur until the appropriate development has occurred—a notion which is a legacy of the work of Piaget (1923) and others. Therefore, the writing instruction could not have been successfully absorbed by the learner unless the developmental abilities, the mental growth, were already firmly fixed in advance. Thus, according to such a view, the mental growth required for progress in mathematics cannot stem from instruction in writing because these mental abilities were established before the writing instruction began.

Vygotsky objects to the way that his model fixes instruction and development in time. The model forces instruction to hobble behind development, when in fact instruction can stimulate development. This is especially true of "proximal development," or what is just outside, but close to, the learner's grasp. Empirical investigation, he says, has shown that such development can be brought within the learner's grasp by suggestions from others. The implication for writing is that instruction in the skill will speed up the development of conceptual thinking, and that conceptual thinking will in turn provide learners with conceptual handles for subject matter formerly too difficult for them.

I have spoken here of two attitudes that have been influential in the development of curriculum planning for in-school writing: (1) that good writing is a single style of writing, and (2) that writing has little to do with general learning and mental growth. Both attitudes reflect narrow conceptions of what writing is and what writing does for

the writer. There are more helpful attitudes now in circulation, especially in the wake of the writing crisis that made headlines in the 60s and the 70s. But the two views explored here are long-standing and deeply entrenched. They have become part of the basic assumptions that undergird research, teaching, and curriculum planning.

The present study begins with the opposite assumption that the cognitive elements of the writing task are enormously important and that we need better and clearer ways to talk about them. Secondly, it assumes that different kinds of writing (as in Table 1) may impose different kinds of cognitive demands. It leaves to future studies, however, the question of how one task is different from another. Only at the end of this study (Chapter 7) is the question raised as to how different tasks may require different thinking activity.

In the main part of this study we are concerned with the way a small group of writers performed one kind of writing task. Who these people were and what they were required to write is the subject of the next chapter.

Notes

1. Mina Shaughnessy, "Needed Research on Writing," **College Composition and Communication** 28 (December 1977):319.
2. Ian S. Fraser and Lynda M. Hodson, "Twenty-One Kicks at the Grammar Horse," **English Journal** 67 (December 1978):54.
3. Nancy Martin et al., **Writing and Learning Across the Curriculum, 11-16** (London: Ward Lock Educational, 1976), p. 66.
4. From an excerpt of the Bullock Report printed in Martin et al., p. 67.
5. Lev Vygotsky, **Thought and Language,** originally published in the Soviet Union, 1934, ed. and trans. Eugenia Hanfmann and Gertrude Vakar (New York: MIT Press and John Wiley, 1962), pp. 94-100. This is the source for all quotations from Vygotsky.
6. E.L. Thorndike and R.S. Woodworth, "The Influence of Improvement in One Mental Function upon the Efficiency of Other Functions," **Psychology Review** 8 (1901):247-261, 384-395, 553-564.

CHAPTER 2

The Biology Students and the Essay Assignments

The Subjects

The 11 students who produced the writing under investigation in this study were participants in the University of Hawaii's Imi Ho'ola Program. The program, federally funded and administered by the Dean of the Medical School, admits 15-20 students each year for the study of material in the sciences. The students are selected because they come from communities and cultures underrepresented in the medical school and in the practice of medicine generally. The object of the program is to prepare as many of them as possible for admission to medical school.

In the group studied were five students from Micronesia or Polynesia for whom English was a second language: two from the Northern Mariana Islands, one from Yap, one from American Samoa, and one from Tonga. Six students, from families of mixed ancestry in Hawaii, were native speakers of English. Since being non-Caucasian is not enough to give one minority status in Hawaii, these six were apparently chosen on the basis of other factors, such as the extent to which they genuinely represented communities in need of doctors. Three were part-Hawaiian, one came from a largely Portuguese background, one was the son of a Filipino immigrant, and one was ethnic Japanese. The communities they represented were mainly rural rather than urban; three came from Oahu, the metropolitan island, and the three others from outlying islands in the Hawaiian chain. Two of these six, the two who had graduated from private high schools in Honolulu, were easily the best writers of the whole group under study. Their skill in both grammar and coherence was quite clear in preliminary writing done in the semester before the biology writing began. The writing of these two, Richard and Karl, was in clear contrast to the writing of the others.

Compared with other foreign graduate students on campus, most of the non-native speakers had good control of English grammar, not surprising since their education had been carried out in English. In the parts of Micronesia and Polynesia where they had gone to school, the high schools ordinarily use English-language textbooks and require almost all writing to be in English. Moreover, the students had attended U.S. universities, usually for three years. Those readers who have taught English composition to foreign speakers will recognize the following sample, written by a student from Saipan, to be quite competent:

> (1) Several body systems are involved in maintaining salt and water balance. (2) These systems, which control the amount of electrolytes and fluid in the body, are crucial for the maintenance and survival of the organism. (3) The two specific systems which will be covered are the exocrine and urinary systems. (4) The exocrine glands are responsible for the secretion of various substances into a duct

> and then to the external environment. (5) These glands do not pour their contents into the blood vascular system of the organism. (6) Among the complex substances secreted by these glands are water and salt. (7) The two compounds are usually secreted to the external environment when they are bound to other molecules.
>
> (Tomas, Essay 12)

The non-native speakers in this group, therefore, cannot be seen as typical foreign students. Although all except Tomas, the writer of this piece, had trouble passing through the program, and although language may well have contributed to their problems, there was nothing in the grammar of their written language that prevented clear communication. The deeper problems of language that made the learning difficult for the ESL speakers are beyond the scope of this study. The distinction between ESL and native speakers is deliberately de-emphasized. We are concerned here with the commonalities—what characteristics are shared by the two groups. As we shall see, one of the most interesting problems in composing is shared by a native and a non-native speaker.

All of the students in the group had taken a science major in high school and college, though differences in their knowledge of science may have been an important variable in their ability to write coherently about the topics given for the present study. One student had taken a botany major rather than chemistry or biology. Others may not have had demanding work in their earlier course work. Ideally a study like this one would use a group of subjects with nearly identical knowledge of the information about which they are asked to write. In point of fact, however, if one wants to study writing within an actual academic program rather than in circumstances designed for an experiment, it may be impossible to find students ideally matched.

The students are listed in Table 2 by fictional first names, according to their success on objective tests of content for the course. On this basis, they rather clearly fall into three groups: high, middle, and low. Table 2 summarizes information about their language, ethnicity, and educational backgrounds.

The Academic Context

The course in which the writing was done was Biology 405, actually called "Biomed 405" because it was taught under the direction of the medical school administration. Information was conveyed through lectures and laboratory work, slides and drawings, as well as assigned readings in two detailed textbooks. Two weeks were spent on the muscle system, two on the circulatory system, somewhat less than a week on the immune system, one week on digestion, one on respiration, two on endocrinology, two on the nervous system, two on the urinary system, and one on the reproductive system. The curriculum was designed not only to review systems the students had presumably studied before but also to simulate some of the frustrating conditions of medical school. In the course, as in medical school, students were faced with a mound of information so large that no one could possibly learn it piecemeal. They were forced to organize the material, to engage in an act of information processing that began as the students took in material during lecture time and should have been apparent in whatever writing or speaking they did on the subject matter.

The course instructors[1] devoted a great deal of time to arranging the material so as to give out the right amount in the right order to help the students learn not just the information but also the skills for organizing it. The instructors saw the weekly writing exercise as an exercise in synthesis. To make the writing function in this way, they worked with me each week to construct a lead-in sentence that would require the students to connect bits and pieces of information from the lectures that had not been explicitly connected in these lectures. It was thus intended that the students would have

Table 2

Subjects Grouped According to Academic Success: Their Language, Ethnicity, and Educational Background

Name	Academic Group	First Language	Ethnicity	Educational Background
Richard	High Group	English	Hawaiian/ Japanese	Selective private high school in Honolulu, college in Honolulu, a few years doing other things after college
Carol		English	Hawaiian	Private high school in Honolulu, mainland college
Karl		English	Portuguese	Parochial high school in Honolulu, mainland college
Tomas	Middle Group	Chamorro and Carolinian	Carolinian (Micronesia)	High school in Micronesia, college in Guam and U.S. mainland
Rudy		English	Filipino	High school on Maui, mainland college
Marilyn		English	Japanese	High school on island of Hawaii, college in Honolulu
Kimberly		English	Hawaiian/ Chinese	Private high school in Honolulu, college in Honolulu
Raphael	Low Group	Yapese (Micronesia)	Yapese	High school in Micronesia, one year in Washington, D.C., mainland college
Fatui		Tongan	Tongan (Polynesia)	High school in Tonga, Honolulu college
Tua		Samoan	Samoan (Polynesia)	High school in Samoa, mainland college
Jose		A Micronesian Language	Micronesian	Complete information not available; presumably high school in the Pacific and college on the U.S. mainland

to find ways of relating the information through written language. Just as the students presumably used organizing principles to take in material efficiently, they would have to use them for writing. The nature of the lead-in sentence would require them to use organizing principles significantly different from those that structured the lecture.

The lead-in was a kind of essay examination question that set the direction of the essay. (The lead-in sentences, dates, and topics of the relevant lecture material are listed in Table 3.) The students were instructed to use the lead-in sentence as their first sentence and then to continue writing so as to elaborate on it. The material for the essay had been provided in the previous two or three lectures, and students were free

Table 3

The Writing Assignments

Essay	Date	Topic	Lead-In Sentence
1	1/26	Muscles	Muscle cells are cells specialized for contraction.
2	2/2	Muscles	Muscle cells transform chemical bond energy into mechanical work.
3	2/9	Muscles	Certain characteristics contribute to important differences between cardiac and skeletal muscle.
4	2/16	Circulation & Muscles	Smooth muscle action affects cardiac output.
5	3/2	Immune & Digestive	The digestive system has immune system components.
6	3/9	Respiratory & Digestive	Increased surface area is important for the functioning of both the digestive and respiratory tracts.
7	3/16	Respiratory	Increased muscular activity increases total pulmonary ventilation.
8	3/21	Endocrine	A hormone may have more than one target cell and thus regulate more than one kind of activity.
9	4/6	Endocrine	(second draft of above)
10	4/13	Endocrine & Nervous	The endocrine and nervous systems can be considered a single control system.
11	4/20	Endocrine & Nervous	(second draft of above)
12	4/27	All systems	Several body systems are involved in maintaining salt and water balance.
13	5/4	All systems	(second draft of above)

to examine their notes before writing so as to review the details. Since they were told to write approximately two pages on wide-lined paper, the required quantity was not great. Of the hour given for the writing, half of the time could have been spent in thinking and review, and some in fact did this. All of the writers were motivated to do well on these assignments because the mark on the writing exercise counted toward the grade for the course. And the course grade, in turn, was important for admission to the medical school.

As for the role that I played, it was rather like that of a teaching assistant. Though I was interested mainly in writing skills, I attended all of the lectures, did most of the assigned reading, and worked under the supervision of the two professors of the course. In the students' view, I was someone who gave out the writing assignment, answered questions if necessary, and graded the papers as an English teacher might, adding comments and encouragement at the bottom of the paper. Each week I put into each student mailbox a carbon copy of what that student had written, together with the comments, a single dittoed sheet with general remarks to the class, and also a sample essay showing how the assignment might have been written. The sample was usually an edited copy of the best essay in the class, sometimes a composite of the three best ones. This dittoed sheet also showed the range of grades, allowing the student to compare his own with the others in the class. The general comments stressed the same three criteria for each essay: (1) How well could a reader follow what they, the writers, were saying? (2) How much relevant detail was included? (3) How correct was the essay in terms of grammar? I also talked individually to students for a few minutes before or after the writing, and on one occasion taped an interview with each student on the subject of organizing information, both for writing and for study purposes. Aside from the strictly academic writing, some of the 11 students sought advice from me about writing application letters.

The Selection of Essays for Analysis

The essays of six students were chosen for detailed analysis, two from the high-scoring group on objective tests, two from the middle group, and two from the low group. The purpose of the study was to determine the relationships, if any, between the structuring of the essays and the academic success of the writers. In particular, I wanted to examine the writing of students who knew a great deal of content material. This material need not have been well organized, but it should at least have been memorized in some way or other. For this reason, students in the middle group whose study skills were erratic and who sometimes appeared not to know the content information were **not** selected for analysis.[2] Likewise, the essays of those in the low group were studied in little detail because they too appeared not to control the information. All the students were clearly motivated to study, but how efficiently they were able to use time, how well they understood the language, how sound their background in science was—none of this was thoroughly investigated. Table 4 summarizes my impressions of their study skills and control of the information.

The two students from the high group whose essays were selected for analysis had consistently scored highest on tests and had very good control of the information. The two selected from the middle group also seemed to have good control of the information, though the course instructors judged that their studying was inefficient.

In analyzing the essays, the most attention was paid to those written by the three students who seemed to have good control of the information but who also had problems of one kind or another with writing. These included Rudy and Tomas in the middle group and Carol in the high group. Of the 13 essays written for the semester, 10 were analyzed for each of these students. Five essays of each of the other three students— Richard in the high group, Tua and Jose in the low group—were analyzed for purposes of comparison with the first three.

Table 4

The Subjects: Their Study Habits, Control of Information, and Grammatical Correctness Before the Course

Name	Academic Group	Study Habits	Control of Subject Matter	Correctness (before course)	Writing Selected for Analysis
Richard	High Group	good*/efficient	good	good	X
Carol	High Group	good/efficient	good	fair	X
Karl	High Group	good/usually efficient	good	good	
Tomas	Middle Group	good/not efficient	good	fair	X
Rudy	Middle Group	good/not efficient	good	fair to poor	X
Marilyn	Middle Group	vacillating	vacillating	excellent	
Kimberly	Middle Group	vacillating	vacillating	excellent	
Raphael	Low Group	sometimes good/ not efficient	poor	fair	
Fatui	Low Group	sometimes good/ not known	poor	fair to good	
Tua	Low Group	good/not efficient	poor	fair	X
Jose	Low Group	not good/ not known	poor	poor	X

*"good" means "put in the time"

Notes

1. The instructors were Drs. Nancy Lind and Sandra Beasley of the University of Hawaii Medical School.
2. Their stories in themselves were puzzling. The two were young women, and though they had the most mature writing skills in the class, they had problems that I believe were connected with confidence and self-esteem as well as conflicting loyalties or ambitions. Three other young women, two of them Samoan, had already dropped out of the program. Their verbal skills were also very good. At least two of these five women had health problems in their immediate families, which demanded their attention. One young man dropped out for a similar reason.

CHAPTER 3

Coherence in the Writing of the Middle Group

Coherence in Writing Related to Academic Success

Over the course of the semester, there were—from the viewpoint of a composition teacher—two obvious problems with the coherence of the student writing: irrelevance and the lack of detail. Irrelevance caused incoherence because it introduced lines of thought puzzling to the reader, who was prepared for some other line of thought. However, lack of detail, strangely enough, made for greater coherence, an effect achieved without much effort. Some of the students sometimes simply spun out a general idea without adding anything that extended it or elaborated on it. Alternatively they left half of the paper blank, in which case the writing that they produced was quite coherent, though shallow and boring. To introduce detail always carried with it the risk that its relevance to the main idea would not be understood. Of course this risk should have been borne. The task, then, was to select enough detail and to demonstrate its relevance.

On this basis the three groupings showed rather clear differences. Those in the high group handled both detail and relevance quite well; there was detail in quantity, and it was admirably organized, though in Carol's case there were numbers of grammatical errors. Those in the middle group produced detail in quantity (with the exception of Marilyn), but the relevance of the detail to the main idea was not always clear. Two of the students, Rudy and Tomas, sometimes introduced whole paragraphs of material that seemed off the point. Of those in the low group, most wrote relevantly but without detail. These students did not have to consider a large quantity of complex information, so it was easy enough for them to write in general terms about the lead-in sentence. Raphael was a frequent offender in this respect; Tua sometimes was. Fatui was an extraordinarily skilled writer, but when short of information or unclear as to how to relate his knowledge to the lead-in sentence, he simply left the paper blank. Jose had neither control of information nor skill in writing coherently, at least on the few samples of writing he produced. Of all those in the group, he was the only one not motivated to study. He frequently missed the writing exercise, and what he did write, unlike the writing of the others in the low group, was neither relevant nor coherent.

Generally speaking, the writing of the high group revealed a grasp of both relevance and detail, that of the middle group showed a grasp of detail only, and the low group was able only to be relevant.

Over the course of the semester the writing development of the middle group was the most interesting. Those in the low group could not really engage in the struggle of message over material because their writing lacked adequate content. At the beginning of the semester, those in the high group already manifested the requisite skills at

producing coherence in writing. It was the middle group, in particular those who had studied the material diligently, Rudy and Tomas, who had both the room to develop and the grasp of material necessary for doing so. Here were classic cases of students who seemed to write just what they had memorized, almost totally ignoring the questions they were to answer or the demands of the assignment.

On the first essay, admittedly, everyone except Richard and Karl in the high group ignored the thrust of the lead-in sentence, "Muscle cells are cells specialized for contraction." Almost everyone wrote about muscle cells—the shape, structure, the number of nuclei, and so on—for the three different kinds of muscle cells, but there was hardly a sentence about contraction. Apparently they found themselves locked into an ordered set of data, much of it unrelated to the processes of contraction. They seemed to know this set very well and to find it easy to lift it straight from their memory of lecture notes, like a large chunk. However, with the exception of Rudy and Tomas, the students had, by the third essay, responded to my admonition to make the essay relevant to the lead-in sentence.

The Chunk Hypothesis

The pattern of the written work of both Rudy and Tomas was one which might be described by a "chunk hypothesis," a chunk being perceived by the reader as a passage that has some sort of internal structure but is off the point of the main argument. At the beginning the work of Rudy and Tomas largely consisted of such chunks, but these either disappeared or became shorter in later essays. By the time the final pieces of writing were produced, both students were quite deliberately imposing their own structure rather than using pre-structured information.

The pattern of the introductory form. One kind of chunk was a descriptive form called here the "introductory" form, one with a characteristic grammatical pattern. Typically, when Rudy and Tomas used it, they nominated a topic for the paragraph, then used this as the topic for almost every sentence.[1] Coherence depended on the repetition of the topic. The predicates of each sentence offered new information about the topic, each one adding something more until there was quite an accumulation of descriptive detail. The form was like that of the following set of sentences for which "Mary" is the topic:

Meet my sister, Mary.
She lives in Newton, Mass.
She has three children, Algernon, Toby, and Elizabeth.
Her husband is in insurance, and she goes to night school three nights a week.

A characteristic of this style is that sentences can be shifted around in a paragraph with little damage to the coherence of the paragraph as a whole. Some sort of overall impression no doubt emerges after several sentences, something that connects the various predicates, but the effect is not one of a step-by-step unfolding or progression. Instead of connectedness between predicates, there is connectedness between sentence topics.

As each sentence in the example above said something about Mary, so each of the student sentences for the first essay said something about muscles. Repetition was the cohesive device, repetition of the paragraph topic. A typical Essay 1 showed a pattern of sentence topics like the one shown on page 19. In almost all of the sentences, except the first one in a paragraph, the topics were the same, and there were few if any reference links from topics back to earlier predicates. This explains why readers felt that the main predicate of the first sentence, "specialized for contraction," was ignored.

Neither did the topics refer to any knowledge assumed on the part of the reader. If, suppose, the sentence topic had been: "The outer covering of the muscle" or "The

Sentence	Sentence Topics
1	muscles
2	muscles
3	muscles
paragraph break	
4	muscles
5	smooth muscles
6	smooth muscles
paragraph break	
7	muscles
8	cardiac muscles
9	cardiac muscles
10	cardiac muscles
11	cardiac muscles

contraction of the muscle," then part of the topic would have been the **understood** sentences:

The muscle has an outer covering.
The muscle contracts.

Part of what the writer would have been referring to is this assumed information. But in fact there were no understood connections of this kind.

Among the sentence topics there was also a notable absence of nominalizations such as "the sliding action of the fibrils," or referring words like "process," which might have been used to refer back to a whole set of events. All this suggests that the sentence topics served a very limited purpose, that of keeping the reader's attention focused on the paragraph topic. Whereas more skilled writers might have used them to refer to earlier predicates, to relationships earlier established, or to knowledge assumed on the part of the reader, these writers were much more limited. In their writing the topics did nothing to link the sentence containing them with the topic/comment connections already made. They made links with earlier topics, not with earlier comments.

What held the sentences together, besides topic repetition, was a parallelism in verb type.[2] Within a single paragraph, the verb type was apt to be the same from one sentence to the next. The type was almost always statal, though there was now and then an exception to this, as in the series:

Certain muscle cells are spindle-shaped.	statal
They have more than one nucleus.	statal
They form bundles.	statal
They move rapidly.	dynamic

The pattern of the introductory form—repetition of the sentence topic and the parallel structure of verbs—produced a student passage like the following:

Topic		Verb Type
(not clear)	The walls of the veins are surrounded by smooth muscles.	statal
smooth muscles	These type of muscles are innervated by the nervous system or by local or humeral influences.	statal
smooth muscles	There are two types of smooth muscles present around the veins.	statal

Topic		Verb Type
type of smooth muscle	One is located in the outermost portion and is called the multi-unit smooth muscle.	statal
smooth muscle	The inner layer of smooth muscles is called the visceral smooth muscle.	statal
smooth muscle	The multi-unit smooth muscles are innervated by the nerves coming from the central nervous system.	statal
smooth muscle	The visceral smooth muscles are innervated by hormones or drugs which have similar effects to epinephrine or acetylcholine.	statal

(Tomas, Essay 4)

Where had the chunks come from, i.e. what was the source of the information used by Rudy and Tomas? Clearly they used what they had learned in lecture, not only the information but the whole organizing principle as well. Since I had sat in on the lectures, I could compare the organizational scheme of the lectures with the structure of the chunks. I found the two types of organization to be much the same.

The introductory form in science textbooks. The structure of the chunks not only resembled the organization of the lecture but also that of several textbooks examined in the course of the investigation. This is hardly surprising, since writers no doubt pick up a sense of the structure of written discourse from what they read. It was interesting that the organizing principle imitated was the one used by professional science writers introducing a new discourse topic, or opening a chapter or new section of material. As in the student writing, the devices for maintaining coherence used by these professional writers were mainly topic repetition and the parallel structure of the verb type. Again, there was not the kind of semantic or logical connection between sentences that one expects in argumentative prose.

This introductory pattern was apparent in the introductory passages of three different science textbooks. The age level or sophistication of the audience made only a little difference in the structuring device used by the authors. The younger the intended audience, the closer the structure was to the one described here; the older or more sophisticated the audience, the more variation in the pattern.

For a sixth-grade text,[3] the pattern was like that used by Rudy and Tomas in their introductory chunk-style material:

Topic		Verb Type
the heart	The heart in man and the other mammals is a muscular organ in the chest region.	statal
the heart	Its primary function is to pump the blood in the blood vessels through the body.	statal (subordinate verb: dynamic)
the heart	The heart is made up of cardiac muscle which is held together by tough, connective tissue.	statal
the heart	About the heart is a tough, protective sac called the pericardium (per'əkar'diəm).	statal
the heart and the pericardium	Within the pericardium and about the heart is a fluid which reduces the friction between the beating heart and the other tissues.	statal

Topic		Verb Type
the heart	The heart is a hollow, muscular organ, shaped somewhat like a cone.	statal
the heart	The heart is divided into four chambers—the left and right atria (atriə) and the left and right ventricles (ven'trəkəlz).	statal

In more advanced texts, the same pattern is apparent, but with more variation. It is used by the authors of a well-written science text[4] that has become part of the Nuffield curriculum project materials for advanced high school ages. The passage reads as follows, slightly paraphrased for convenience. (The exact version appears in Appendix A.)

> There are three types of muscles.
> Cardiac muscle is immune from fatigue.
> Smooth muscle has discrete cells, each with a nucleus.
> Smooth muscle is slow to act.
> It is found in the gut and bladder.
> Its rhythm is controlled by the nervous system.
> It can exert a large force for a long time.
> These cells can lock themselves in a contracted state.

Except for the first two sentences, the topics are "smooth muscle" or "smooth muscle cells." Except for the relation between "slow to act" and "long time," there is little connectedness between the various predicates. (A few example sentences have been omitted that were related to the general statements they followed.) The most telling evidence is that several sentences could change their positions in the paragraph without damage to the structure of the paragraph.

The introductory form used by the students, then, has two significant characteristics. First, it is remarkably like that of the introductory paragraphs of the examined textbooks, and second, its strategies for coherence are grammatical rather than rhetorical. When it came to listing rhetorical connections such as cause, comparison, or illustration, I could find very few. Both characteristics may explain why students chose the form they did. They imitated what they saw and heard, but they imitated those forms that required not rhetorical or logical relatedness between statements but rather a kind of topic relatedness.

Such a form is appropriate for the opening pages of the chapter of a textbook, when very little knowledge is assumed on the part of the reader, but is not appropriate for a student essay that should presuppose a good deal of knowledge on the part of the reader. The lead-in sentence for each assignment signalled what information should be taken for granted, or presupposed. What the students did in using the introductory form was to **assert** what was **presupposed**—clearly a violation of a basic communication code.

Chunks in the Work of Rudy over the Semester

Most of the remainder of the chapter will examine the semester's work of Rudy, one of the two students for whom there was a genuine struggle between material and message. (See Appendix B, which includes portions of a number of Rudy's essays, as well as the full text of his Essay 12.)

Both Rudy and Tomas seemed to have invested a great deal in their study of the content. It must have taken a long time for them to memorize it. For them, doing this marked the difference between failure and some measure of success. For Tomas, the

ability to study and memorize had no doubt been the reason for his earning a scholarship to the University of Washington after a year at the University of Guam. As for Rudy, he had got where he was by buckling down in college. In high school he had done no studying to speak of, he told me in his interview, and now he knew what it was to study. Both were reluctant to give up or change the structure of the material in their possession. Rudy is the focus of much of this chapter. He was the more reluctant of the two to change, and his writing presents a clear example of what seems to be a common difficulty for academically successful minority students.

A trade-off between relevance and style. When Rudy used chunks, his writing was readable. When he did not, his writing was incoherent in the usual sense of the word, quite without logic or flow. His writing fit one of these two descriptions for the first nine essays he wrote. The first two essays, though they went off in the wrong direction, were readable. In view of this fact, Essays 3 and 4 were astonishing. They were bewildering to read and full of bumps and jolts.

Contrasted with Essays 3 and 4, Essays 1 and 2 were easy to follow, provided one could ignore the first sentence. In fact, the prose of Essay 2 was so smoothly put together that it encouraged me to do just that—ignore the first sentence. The structure was essentially a listing technique but more complex in structure than the introductory format. The topic that Rudy wrote about was one commonly covered in textbooks—the methods used by the body for generating ATP, the energy needed by the muscles for contraction. Rudy established that there were several ways of generating this energy, then proceeded to name them—"glycolysis," "oxidative phosphorylation," and so on—and also to show at what points each method came into use. The grammar was correct, the prose, though complex, was easy to follow, and everything was related to the general notion of methods for generating ATP. For that paper Rudy received one of the highest marks he was to receive all semester, a B+. There was just one oversight on my part: the lead-in sentence asked **not** how ATP was generated but how it was used by the body **after** it was generated. The whole essay was off the point and should have received a low mark. A passage from this essay is included below to illustrate the smoothness of what was really a chunk of material irrelevant to the lead-in sentence. The excerpt is typed as it was written, although sentence numbers are added for convenience.

Excerpt from Essay 2

> (1) There are several ways of generating ATP or producing ATP for muscle contraction. (2) Normally the production of ATP is found to occur within the cytoplasm of a cell and also within the mitochondria of the cell. (3) If ATP is produced within the sarcoplasm of a muscle cell, it is normally ATP production from glycolysis. (4) If ATP is produced within the muscle cell mitochondrion, it is called oxidative phosphorylation. (5) Besides glycolysis and oxidative phosphorylation, ATP can also be produced from phosphagen pools, such as creatine phosphate and orginine phosphate.

Essays 3 and 4, which were incoherent hodge-podges and which received low grades, clearly exhibited Rudy's efforts to make the essays more relevant to the lead-in sentence. The chunks were broken up by sentences which Rudy intended would function as links to the lead-in sentence. But these bridge-like sentences had the effect of breaking up the flow of information, impressing the reader as interruptions.

In Essay 3, the lead-in sentence states that differences in the structure of cardiac and skeletal muscle are suited to their differences of function. Rudy follows this up by attempting to show that the different membrane properties of the two kinds of muscle

cells allowed ions such as sodium and potassium to move in and out of the cell in greater or smaller quantities. This difference, in turn, is responsible for different rates of contraction for the two kinds of cells.

But the words "different," "greater," and "smaller" introduced the notion of comparison into what were, for Rudy, two separate lines of thought, one concerning skeletal muscles and one about cardiac muscles. Rudy obviously had extreme difficulty in keeping his information about these muscles subordinate to the comparative purpose. The output—and hence the hodge-podge effect—is a series of unconnected sentences, some with comparisons, some without. Sentences 6, 8, and 9 have no connection to the comparison ideas in Sentences 3, 4, and 7. The comparison sentences explain that one kind of muscle cell is slower to contract than the other. The other sentences state that the important ions are calcium, sodium, and potassium. Sentences 8 and 9 give more detail about ions, specifying where they are found and what the purpose of calcium is. All of this is puzzling, to say the least, because the link between contraction and ions has not been made. Admittedly the link was made in Sentences 2 and 5, but the other sentences must also refer to the relationship or be seen as irrelevant to the paragraph. The general reader would have no choice but to view most of the sentences as irrelevant—unless he is a sympathetic biology professor who uses his own knowledge to fill in the missing relationships. To make matters worse, a major grammatical fault at the beginning of Sentence 2 makes this sentence unreadable. The sentence is attached as a "run-on" to Sentence 1, which therefore makes the impression for the reader one of almost total incoherence.

Excerpt from Essay 3

> (1) Certain characteristics contribute to important functional differences between cardiac and skeletal muscle. (2) [sentence fault] are primarily related to the movement of certain intracellular and extracellular inorganic ions. (3) The primary functional difference between skeletal muscle and cardiac muscle is due to the rate of contractions. (4) The rate of contraction of skeletal muscle is much slower than the rate of contraction in cardiac muscle. (5) The rate of contraction in muscle cells are directly influenced by the permeability of the muscle cell membrane to certain ions. (6) The change of the muscle cell membrane permeability, as a result of nerve stimulation, can cause an action potential to be generated throughout the cell membrane. (7) The magnitude of the action potential is somewhat directly proportional to the rate of contraction. (8) The principal inorganic ions which play an important role in muscle contraction are calcium, sodium, and potassium. (9) Potassium is the principal intracellular ion, sodium is the principal extracellular ion, and calcium is an important ion that promotes muscle contraction.

Overall, the contrast between the passages from Essays 2 and 3 could not be more marked. Essay 2 is smoothly structured and easy to read. Essay 3 is nearly impossible to read. But the first is a prefabricated chunk—put down on paper as it must have been received—while the second marks Rudy's own attempt to bring together information that had not been brought together for him in lecture. At this point in Rudy's development there is a trade-off between relevance and readability. When he tries to advance the assertion made in Sentence 1, he produces chaotic prose. Only when he reproduces the material in the form he received it does he produce smooth, flowing prose.

The trade-off at the sentence level. Sentences in Essay 3 appear to be newly unchunked or pulled out of whatever structure they were part of. The ones with no comparative force follow. Notice that they are concise, smooth, and graceful, like short versions of longer chunks.

6. The change of the muscle cell membrane permeability, as a result of nerve stimulation, can cause an action potential to be generated throughout the cell membrane.
8. The principal inorganic ions which play an important role in muscle contraction are calcium, sodium, and potassium.
9. Potassium is the principal intracellular ion, sodium is the principal extracellular ion, and calcium is an important ion that promotes muscle contraction.

These small chunks, like the large ones, were irrelevant to the author's purpose, even though they were smoothly written. The "new" sentences created by Rudy to meet the demand for comparison were relevant but poorly written or wordy:

3. The primary functional difference between skeletal muscle and cardiac muscle is due to the rate of contractions.
4. The rate of contraction of skeletal muscle is much slower than the rate of contraction in cardiac muscle.
7. The magnitude of the action potential is somewhat directly proportional to the rate of contraction.

In a sense, therefore, a hodge-podge essay was a sign of development, for ordinarily this meant that Rudy's long chunks were being broken up. The sentences most disruptive in the line of thought were attempts to re-establish a link with the lead-in sentence. Though he could not quite manage it, Rudy attempted to integrate what he must have seen as two separate topics, one comparison and the other muscles. The topic of muscles had the sub-parts skeletal and cardiac. While he failed to integrate the two topics successfully, he at least brought them together by juxtaposition. That is, a content sentence like 6 was juxtaposed with a comparison sentence like 7.

The dull, clumsy sentences (for example, 3, 4, and 7 above) were indications that some sort of relating work was in progress, in this case comparison. Indeed, some sentences of this type could well be called "working sentences," for it is clear that in writing them, Rudy had to fumble and search for a means of expressing the comparative relationship. He no longer had the fluency and confidence he had when writing chunk-style information.

Such "working" sentences also occur in his Essay 6, whose general topic was the importance of surface area for the digestive and respiratory systems. At one point he wanted to say that small structures exist within both the lungs and the small intestine that poke out from the surface, so that there is a great deal of surface area. Over this surface area gases are exchanged in the lungs or nutrients are absorbed in the intestine. The structures in the lungs are called alveoli, those in the intestine villi and microvilli.

In writing this, Rudy got as far as saying that there were alveolar ducts in the lungs. At this point he wanted to say that the more alveolar ducts there are, the more alveoli there will be, and the more alveoli there are, the more surface area, and the more surface area, the greater the opportunity for efficient gas exchange. In the process of trying to say this, his sentences became labored, full of crossouts and insertions. Consider what he must have been trying to do as he wrote and crossed out the following:

> Therefore, the more alveolar ducts ~~there~~ in the lungs will have more alveolus and hence, a greater exchange of ~~gas carbon dioxide and oxygen~~ surface area for gas exchange to take place efficiently.

He labored over the connection between the greater number of alveolar ducts and the greater number of alveoli. Still it did not come out quite right:

the more alveolar ducts in the lungs will have more alveolus

Crossing out the "there" in the first line released him from one kind of sentence structure, which would have been:

the more (something) there are, the more (something) there will be

At the same time the change of structure caused by the deletion of "there" led to a fault in the second part of the sentence. Now it read:

The . . . ducts . . . will have more alveolus and hence a greater surface area . . .

To say the ducts will have greater surface area was inaccurate, as it is not the ducts but the lungs that will have the greater surface area.

The relation of chunking to Rudy's perceptions and purposes. Essay 6 was a high water mark for this time of the semester. Not until Essays 10 through 13 did Rudy again show the same willingness to focus directly on the argument laid down in the lead-in sentence. Most of the other essays were off focus, either completely (as in the irrelevant Essay 2), somewhat (as in Essay 5), or just slightly (as in 7 through 9). In all of these essays he used small chunks of information that seemed to be pulled from an "introductory format." When a noun was introduced, it was frequently accompanied by a sizeable quantity of irrelevant information—names of things and random properties or attributes. Perhaps the confusion he encountered in writing Essay 3 and the syntactic difficulties in which he found himself in Essay 6 persuaded him that it was best to stick to information he felt comfortable with and not to attempt the more ambitious task—breaking the information down, extracting the relevant bits, and then recombining them.

More likely, however, the changes in Rudy's willingness to attempt this kind of shuffling of information should be viewed as a function of the assignment rather than changes in his attitudes or perceptions. Some of the lead-in sentences (and these included the ones for Essays 3, 6, and 10 through 13) left Rudy no choice but to build a structure of information that suited the assignment. This was because the lead-in sentences linked two body systems, such as the respiratory and digestive systems, which had not been linked in class lectures. There was thus no large body of notes about the connections between these two systems, and consequently Rudy could not "borrow" the structure of this information. All of the other lead-in sentences (the ones for Essays 1, 2, 4, 5, 7, 8, and 9) concerned themselves with a single body system. Since lectures were organized around body systems, there were whole blocks of information on the subject, or chunks, which Rudy felt free to use without modifying the sequence of information.

Essays 5, 7, 8, and 9 were all in this category, including both relevant and irrelevant sentences. Aside from the first sentence, the essays as a whole read like interconnected pieces of writing. They began at a particular point, proceeded through an orderly sequence, and then ended—all very nicely arranged and readable. But the burden was on the reader to find the relevant material. Rudy had not taken on the responsibility of structuring the information so as to make its relevance clear.

Take, for example, Rudy's Essay 5 (see Appendix B), for which the lead-in sentence was: "The digestive system has immune system components." The intended topic is the immune system components that are located in the digestive tract, these being, in some cases, structures like lymph nodes, in others, structural features like tight-fitting "junctions" between cells to keep out invading bacteria, and, in still other cases, processes like mucus secretion or phagocytosis, a kind of swallowing-up of the invading bacteria. Arranging this information was a complex task. Most students did it by cate-

gorizing the data in one way or another—as **specific** and **non-specific** responses or as **physical** and **chemical** barriers. Some classified the immune components by their location along the digestive tract—**higher, middle,** and **lower.**

But what Rudy did was an extreme of this last method, the "geographical" one. He had apparently learned his information in this arrangement and could not change the structure of what he had learned. He began his essay by naming the four layers of the wall of the alimentary canal, or the digestive tract—again the introductory format. Having done so, he then mentioned immune components. And why? Because he had arrived at their location. The components were located in the top two layers of the digestive tract. He did the same for the sub-layers of the topmost layer. He used four sentences to name these layers, and having arrived at the appropriate sub-layer (the "lamina propria"), he mentioned the immune components based in this layer. It was not that he felt immune components were unimportant, only that they should wait until he had made his way to their site. His method not only obscured the relevant detail about the immune components, but it also encouraged him to introduce irrelevancies such as "loose connective tissue," which had nothing to do with either digestion or immune functions but happened to be found at this site.

Not until the end of a long paragraph does the reader find the expected material about immune defenses. Although the relevant material is well written, its placement at the bottom of the paragraph nearly obscures it. Of the first 14 sentences, only six relate to the immune system. The other eight are taken up with the naming of layers. In subsequent paragraphs, the proportions are changed, giving more space to immune components and less to digestive layers. But even here the inappropriate structuring of his information is apparent from the connective devices used in the opening sentences of his paragraphs. The following is a typical paragraph opening:

> The submucosa is the next layer adjacent to the mucosa layer. This layer consists of dense connective tissue and also an accumulation of lymphoid tissue. These lymphoid tissues are responsible for processing specific immunological cells . . .

To the reader, who expects the immune components to be primary and the location in the mucosa to be secondary, such a paragraph opening is strange. But it was apparently not strange to Rudy. The lead-in sentence had begun with the digestive system ("The digestive system has immune system components"), so why shouldn't he?

In a taped interview with Rudy he indicated at first that his problems with relevance were caused by the length requirement for the writing exercise. To be direct or "to go right to the point of the lead-in sentence" would cut down on the amount of material he could use. There was quite a discussion about "direct" writing:

Rudy:	If I write something direct, I [unclear] not fill up the two pages.
Interviewer:	Is **that** what's bothering you?
Rudy:	Yeah, that's what's bothering me.
Interviewer:	Hmmmm.
Rudy:	See, like I think—I dunno—you're expecting us to fill the two pages, right?
Interviewer:	Yes, but you know what—you write about twice as much as anybody else.
Rudy:	Yeah, but if you talk specifically, directly, it's going to be only one page.
Interviewer:	Do you think you could take a risk and try it?
Rudy:	Well, for instance, I could talk about smooth muscle, its involvement in cardiac output. I could summarize it in this much, I think. [Gestures to indicate a small space.]

For Rudy an important cognitive problem—a problem shared by many students—

was in not knowing how the information within his control bore on the general statement in the lead-in sentence. In the case of smooth muscle and cardiac output, it was a problem of figuring out which information was needed for elaborating on the sentence, "Smooth muscle action affects cardiac output." This sentence refers to the fact that the muscles lying in the main blood vessels have some effect on the amount of blood put out by the heart with each beat. To the students in the high group, the relevant material was a chain-like series of events that began with the squeezing action of the muscle and ended up with greater cardiac output of blood. There were several steps in the process, all complex.

But Rudy's next remarks in the interview reveal the way in which he selected material for its relevance to the statement.

Interviewer: O.K. Let's try it [the direct way]. Just for a little exercise here, suppose you went **directly** to it [pointing to the sentence "Smooth muscle action affects cardiac output"]. What would you say?

Rudy (reading): "Smooth muscle action affects cardiac output." O.K. . . First, I would write about the location of smooth muscle in blood vessels . . . O.K. . . and how they are arranged.

Interviewer: O.K. To **me** that's not direct:

Rudy: It's not direct? O.K. . . To me, it's direct. The way they are arranged is the way they contract. They have certain ways of contracting. Arteries, O.K., they are arranged circally . . . O.K. . . and as the smaller the vessel gets, there is more smooth muscle there.

To Rudy, the "direct" way to talk about the effect of smooth muscle action on cardiac output was to describe smooth muscle, to say where it is located, and how it is arranged. Sooner or later he would get around to the part about cardiac output. Rudy didn't see any problem with this. He would get to the point—what the smooth muscle did and how it made the output of the heart smaller or greater—if the reader would wait. He had come to the connection between muscle structure and muscle function (Essay 1) after the first 25 sentences. He had returned to the point of the lead-in sentence in Essay 2 in the last sentence, Sentence 35. One senses from his remarks that the proper place to come to the point of the central relationship is in the conclusion. The bulk of the essay should consist of material that naturally **comes first.** What comes **first** is location, arrangement, definition, the naming of component parts, and appearance.

His next taped comments were on the topic of cardiac muscle. (The marks of emphasis are his.)

Rudy: We was talking about cardiac muscle. O.K. What I do—like—I would **explain** what is cardiac muscle, physical characteristics of it, then I would explain the chemical characteristics, then I would conclude.

Interviewer: How would you conclude?

Rudy: Uh—to summarize the physical and chemical characteristics, that's all . . . what I see as important.

Interviewer: What do you see as "characteristics?"

Rudy: Physical characteristics is like location . . . and what a thing looks like . . . and comparing that with other muscles and based on that . . . physical appearance . . . what certain features that they can do.

My remarks about "directness" had missed their target. Rudy agreed that writing should be "direct," but whereas I had meant that it should bear directly on the assertion of the first sentence, Rudy felt that one should go directly through the "appropriate" sequence of information. First in Rudy's scheme of things were statements

about the structure of the body. Statements about the way the body parts work come along later, these being the "features that they can do."

It became clear from reading his Essay 7 that when the appropriate sequencing was a time sequence, he felt it necessary to start at what he considered the "right moment" in time. Thus when the lead-in was, "A hormone may have more than one target cell and thus regulate more than one activity," Rudy quite correctly thought of the chronological sequence of hormones traveling to target cells and then causing those cells to act in certain ways. But for him the right moment in this sequence was not the moment of hormone secretion. For him the narrative properly began with the existence of **glands** because it is glands that secrete hormones. Even though glands were not relevant to the writing task, their existence was seen as prior to that of hormones. Therefore, all Rudy's examples of hormones begin with the naming of glands. Glands **belonged** at the beginning and could not be lopped off. There are, therefore, "extra" sentences at the beginning of each example narrative, sentences that the patient reader must find his way through in order to arrive at the relevant material. For instance, in the following passage the relevant information makes its appearance only in Sentence 6 and after.

> (1) A hormone may have more than one target cell and thus regulate more than one kind of activity. (2) Specific body organs that secrete these hormones which act upon more than one target cell are the adrenal medulla, thyroid gland, parathyroid gland, and pituitary gland. (3) The adrenal medulla is a neuroendocrine transducer gland. (4) After receiving a sympathetic postganglioni stimulus, the adrenal medulla secretes the neurotransmitter, norepinephrine. (5) Norepinephrine is then dumped into the blood and is carried to the specific cells that it will react with or affect. (6) Norepinephrine can act upon numerous cells of the body. (7) Norepinephrine can regulate heart rate, oxygen consumption and insulin production. (8) The adrenal medulla also can secrete another hormone called epinephrine . . .

Teacher intervention: Rudy's case. Rudy's reluctance to change was both a disappointment and a challenge to me. Surely it was possible to show a student that information, while it could be usefully stored away in a tight structure, had to be extracted from that structure to suit the demands of the discourse. Once more I tried what was, to me, a direct approach. This time I circled all the relevant sentences of Essay 8, then copied them out on a separate sheet of paper to show that these sentences on their own would make a connected essay. I wrote a comment at the bottom of the essay, asking Rudy to read the revised version and to compare it with his returned copy on which all the relevant sentences had been underlined. All sentences **not** underlined, said the comment, counted against his grade, even though they were true.

The last bit of this comment must have rankled, for when Rudy came to the next writing exercise, he looked wounded and a little hostile. "Why I get so low grade?" he asked. "I write all true things. My grammar? Is it bad? What you grading on?"

My response was a general one: relevance was important and some material, even though it was true, was not relevant. In a piece of writing, irrelevant material was confusing.

In the middle of the writing exercise, he came to the desk for more paper. "Maybe," he said, "yeah . . . maybe I catch."

On the essay he wrote that day, however, his method was the same as before. Doing a rewrite of the essay on hormones and target cells, he began again with the **glands,** and again presumably because the information properly **began** with the glands. Rudy's information, as always, seemed bound to the structure in which he had received it.

But when it came to the last four essays, Rudy showed that he had figured out how to select the relevant material. (See Essay 12, Appendix B.) At this point in the semester, and on an assignment which gave him no choice but to build a structure of his own, he

was able to do it competently. There was marked progress over his early essays, although no definite assurance that he would not be distracted in the future by those structures of information with which he was already familiar.

Rudy's apparent conviction that a given piece of information belonged to a given information structure was one shared to some degree by several others in the group. Tomas too had the tendency to pick out a noun phrase from the first sentence and then provide information about this single noun phrase. Typically, he either named it, defined it, located it, or specified its component parts. This tendency explains the occurrence in the writing of both students of sentences like: "This type of contraction is called the isovolumic contraction," or "This is a simple columnar epithelium," or "This cycle has four stages." Such sentences either occurred alone, in which case they were momentary distractions with no apparent relation to the argument at hand, or they were part of a **set** of such sentences, none of them related to the argument of the lead-in sentence. In either case they were there not because the student made a mistake but because he thought it right and proper, having introduced a noun phrase, to produce its adjunct information. For a teacher to advise subordinating—or sentence combining—would probably have little effect in the long run. As shown by later essays, both Rudy and Tomas knew quite well how to subordinate information of this type. In their early essays they did not subordinate such information because they did not believe the information was subordinate. Names, definitions, locations, and component parts were important enough in themselves to merit the status of main clauses.

Other Students and Chunking

Other students were also inclined to view certain information as fixed, as inflexibly bound into a particular arrangement with other information. When the subject was the circulatory system, the information should have begun, in their view, with the heart. Thus, when the lead-in sentence was, "Smooth muscle action affects cardiac output," there were two or three students who shook their heads and wrinkled their brows. One student stared at the paper for at least five minutes, finally looked up, laughed a little, and said with some exasperation, "Smooth muscle? You can't start there."

For this student and others, the action of the smooth muscle was somewhere in the **middle** of a process, since smooth muscle was located not in the heart but in the blood vessels. The story of circulation properly began with the heart and with the cardiac muscle located in the heart. The role of smooth muscle did not rightly enter in until later in the story when the blood had traveled out of the heart, through the arteries, and into the smaller arterioles, where smooth muscle was located. So binding was the story of circulation, as it is usually told, that students could not see the events of circulation structured in any other way.

The 11 people in the study could be categorized according to the degree to which they were bound by the way the information had been structured when they had learned it. Rudy and Tomas were certainly the most committed to this structuring. The other nine students were much less so, but of these nine, the freedom from structure was an advantage only for those in the high group. For the low group and, to some extent, the rest of the middle group, flexibility did not help. Except for Marilyn, late in the semester, they apparently did not make the prodigious effort made by Rudy and Tomas to memorize information in the order of the course outline. Perhaps they had less general science background when they began, perhaps their study habits were weaker, and perhaps the four non-native speakers had trouble with quick comprehension of the language. Of the non-native speakers, only Tomas was able to gain sufficient mastery over the material, in this his second try at the program.

For those in the low group the first step toward better learning might well be the memorization approach. For them to view circulation as having a fixed starting point was perhaps a good beginning. The consequence of such a learning strategy might

well be writing that followed slavishly the structure of the memorized information, but this may have been a necessary step.

It was surely a cognitive effort of some proportion both to store the required quantities of information, in whatever fashion this might be, and also—on command—to shuffle the information so as to create a structure appropriate to the writing task. There were two students in the high group, Carol and Richard, who structured and restructured as though it were second nature; another student, Karl, was almost as skilled. Not only were their essays impeccably organized and almost free of irrelevancies, but they were also shorter than those of Rudy and Tomas. They wrote less and spent more time gazing into space than did Rudy and Tomas; in other words, the signs of conscious manipulation and structuring were there.

In conversation as well there were signs that they processed information rather consciously. Richard, in the course of his interview, showed that he organized the course material hierarchically. Starting with the body as a whole, he thought next of the systems that make up the body, the organs that make up the systems, the various components that make up the organs, the cells that make up the components, and finally the parts that make up the cell. **But,** he said, you can also think of the information as beginning with the chemistry of the cell. What happens there affects what happens to each bigger component on up the line. So you can go down the hierarchy or up; it makes no difference. **Or,** he said, you can think of the structure of the body vs. the function of the body. **Or,** he said, you can sometimes think of it all as a battle between disease and health. The body does such and such **if** such and such happens. Certain events occur under pathological conditions, and others occur under healthy conditions. This student, obviously, took the time to stand back and look at the forest, and as a result he knew more than the names of the trees.

Carol was the other student whose structuring abilities were impressive. She quite consciously organized her material in terms of generalizations and examples, differences and similarities, causes and effects. She talked in this vein during her interview and wrote at the end of the course on her evaluation that she would study for the final in the way that she thought about her essays—looking for relationships between the items of information.

The later essays of Rudy and Tomas were relevant and coherent—each paragraph, for instance, related to the lead-in sentence by a referring sentence of some sort. This shows that with practice they were able to work with their own organizing principles rather than borrowed ones. Presumably they, too, will be able, both in speech and writing, to reshuffle information to fit a particular discourse demand.

Will they ever be like Richard and Carol? Perhaps not completely, for habits, by definition, are hard to break. Yet there is in their writing some evidence for the belief that what they showed in their early essays—the chunk-style—is a **developmental** stage. For them, perhaps, it was useful for their final success, both in learning and in writing, to begin with information in some pre-structured form. The process of breaking and recombining for purposes of arguing a certain point may be so demanding in itself that students cannot handle it at the same time that they are in the process of retrieving information. Clearly there is something very difficult about the process of recombining material.

It is worth more than a footnote to say that Rudy and Tomas were among the six of the original 11 students who were admitted to medical school. The other four were Richard, Carol, and Karl in the high group and Marilyn in the middle group. Marilyn made a prodigious effort in the last few weeks, overcame some personal problems, and managed to learn a mountain of information before the final examination. None of the students in the low group were admitted, but Tomas' experience is instructive, for in his second try at the program, he was successful. It is fair to infer that in the first year, he was overwhelmed by the information and only in the second could he begin to make sense of it.

Notes

1. See the last few pages of Chapter 4 for more on sentence topics.
2. Type refers to the categorizations **statal** or **dynamic,** where statal characterizes verbs like have, be, or own, that go with states or conditions, and dynamic refers to movement, action, or change. (See also the discussion at the end of Chapter 4.)
3. Ralph P. Frazier and Herbert A. Smith, **The Biological Sciences** (River Forest, Ill.: Laidlaw Brothers, 1969), p. 306.
4. R.A.R. Tricker and B.J.K. Tricker, **The Science of Movement** (London: Mills and Boon, 1966), p. 68.

CHAPTER 4

Concepts from the Literature

Studies of composing processes by Janet Emig[1] and others suggest that Rudy is not alone in his reluctance to change the structure of his information to meet the demands of a writing assignment. In her classic study of twelfth graders' composing processes, Emig found that even her most verbal writer, Lynn, was reluctant to take up a topic on which she had done little mental structuring. As Emig notes, such reluctance is a general trait: "If, according to the writer's perception, the period is curtailed by his own schedule or by others, he usually does not elect to work on a topic or problem he regards as cognitively complex."

What is needed now is a definition of coherence that takes cognitive complexity into account. For present purposes, we will take cognitive complexity to refer to two parts of the composing task—the problem of generating relevant information and the problem of making it fit the mold imposed by the assignment. We noticed that Rudy made progress toward shaping his information to fit the task when he began to compare, generalize, or specify. Although his first tries were nearly unreadable, they seemed to be the first step in a right direction. We noticed also a reluctance to shift out of a certain, perhaps memorized, information structure when the task demanded a different structure. It follows from these observations that our definition of coherence should consider the contrast between two kinds of information structure—the structure Rudy tended to use contrasted with the structure that was required.

The scholarly work of others is helpful for this purpose, especially for sharpening the terms of analysis. Let us look at two types of terms: those which are offered by modern rhetoricians concerned with the teaching of writing, and those offered by linguists and their colleagues in cognitive psychology.

In the work of the rhetoricians there is generally a claim, implicit or explicit, that the structure of text is related to the structure of thought. Francis Christensen's (1967) generative rhetoric of the paragraph focuses on the amount of abstracting that a writer must do, showing that paragraphs differ in the amount they move up and down the abstraction ladder. His analysis depends on a distinction, almost intuitive in nature, between subordinate and coordinate. A sentence that is coordinate to the one preceding it—that is, having an "and," "but," or "or" relation to it—is said to be on the same level of abstraction. But sentences that define, explain, qualify, or illustrate earlier sentences are said to be subordinate to them, or on a lower plane of abstraction. The recent Nold/Davis analysis (1980) is an elaboration of the Christensen model, adding to it the claim that sentences go not only **down** in terms of subordination but **forward** in terms of relationships like contrast and **sideways** in term of superordinate relationships. Nold and Davis claim that their model helps to explain the mental processes of a writer, a claim that is to some extent borne out by the recent research done by Matsuhashi and Cooper (1978). When these two researchers measured the time that writers paused between the writing of one independent clause and the next, they found

that the longest pauses came before the writing of what Nold and Davis refer to as superordinate clauses.

The claim that the structure of text, in general, reflects the structure of certain thought patterns is made quite explicitly by Frank D'Angelo in his **Conceptual Theory of Rhetoric** (1975). Patterns of discourse, he argues, are related to processes in the head of the writer; they represent "dynamic organizational processes"; they are "symbolic manifestations of underlying mental processes and not merely conventional static patterns" (p. 57).

What are these patterns of discourse, or text, and how do they match up with thinking processes? D'Angelo quotes Dudley Bailey, who specified four such patterns of "logical" thinking: the text pattern linking detail to general ideas is related to the thinking process of **induction,** definition or analysis is related to **categorization,** comparison/contrast is related to **thinking by analogy,** and hypothesis is related to **thinking about cause/effect** (D'Angelo, p. 17). D'Angelo's theory of rhetoric differs in detail but more or less follows this line of argument. His complete list of discourse patterns follows:

LOGICAL PATTERNS OF ARRANGEMENT

I. Static Logical Patterns
   - A. Description
   - B. Definition
   - C. Division into Parts
     1. Partition
     2. Enumeration
   - D. Classification
   - E. Exemplification
   - F. Comparison
     1. Similarity
        - a. Literal
        - b. Figurative
     2. Difference
        - a. Kind
        - b. Degree
          1) Greater
          2) Lesser

II. Progressive Logical Patterns
   - A. Narration
   - B. Process
   - C. Cause and Effect
   - D. Syllogistic Progression

III. Repetitive Logical Patterns
   - A. Iteration
   - B. Negation
   - C. Alternation

NONLOGICAL PATTERNS OF ARRANGEMENT

I. Fantasy
II. Hallucination
III. Dream
IV. Reverie
V. Vision
VI. Trance
VII. Meditation

(D'Angelo, pp. 57-58)

Like other rhetoricians, D'Angelo sees significance in the difference between so-called "logical" and "non-logical" patterns of text structure. Presumably the goal is to distinguish between types of text structure that demand logical thinking and those that do not. D'Angelo's "non-logical" category is rather narrow: only fantasy, dreams, and such are placed here. Temporal and repetitive patterns are placed in the "logical" category. Bailey, on the other hand, would treat temporal and repetitive patterns as "non-logical" and reserve "logical" for the four patterns named earlier: detail, definition/analysis, comparison/contrast, and hypothesis (cause/effect).

Lee Odell (1977) would, I believe, put time and space connectives inside the "logical" category but would leave the features of repetition or parallelism in the "non-logical" category. This seems evident from his article comparing the density of logical information in two drafts of a student composition. His analysis of the improvements in the second draft focuses on the greater number of rhetorical connections: four times as many references to physical context, eight times as many actions within a time sequence, five times as many causal sequences, more contrasts, and more kinds of contrast. Such evidence, asserts Odell, is a measure of the writer's intellectual development.

Despite differences between rhetoricians about the scope and meaning of "logical," or "rhetorical," we find general agreement on the importance this element is assigned in describing the structure of text.[2] This agreement is a first feature of the work done by rhetoricians.

A second and unfortunate feature is a neglect of syntax. While we have terminology in abundance for describing the structure of text, we still have difficulty in determining **where** the logical element resides in the text: in what words, in what position of the paragraph, or in what units of the sentence. D'Angelo's work is an exception in this respect. He seems quite interested in the ways that logical or rhetorical information sometimes surfaces in the structure of the sentence. He notes, for example, that a text pattern like similarity (i.e. comparison/contrast) corresponds to the sentence structure "something is like something." The conceptual patterns may or may not show up on the surface of the sentence, depending on the level of discourse at which they operate:

> Whereas patterns of thought manifest themselves as conceptual patterns of discourse, these conceptual patterns are embedded in sentences, in paragraphs, and in longer units of discourse. On the sentence level, they are stylistic. On the discourse level (the paragraph, the whole theme), they are organizational.
>
> (D'Angelo, p. 28)

As for the surface connectors such as "but" and "on the other hand," rhetoricians grant that they are important to the logical cohesiveness of the text. E. D. Hirsch[3] claims that these phrases (and others such as "moreover," "therefore," "consequently," and "similarly") should be a more important part of composition textbooks than they are now. Such "proleptic devices," he says, serve the double function of "constraining the meaning of the ongoing clause and integrating that meaning with earlier ones." Shaughnessy[4] calls them "a basic vocabulary of logical connectives," which, she found in her investigation, were used very little by underprepared college writers, who tended instead to use a comma or an "and."

What has probably kept rhetorical theorists from making more of the role of such connecting phrases in composition is the knowledge that whole passages can be written quite successfully without their use. As with D'Angelo's observation that conceptual patterns occasionally surface as sentence structures, we are struck by the elusive nature of the logical elements which bind prose together.Sometimes they show up as surface features, sometimes they don't.

Joseph Grimes (1974) has dealt with this problem by positing the existence of "rhetorical predicates." A linguist, Grimes represents each piece of rhetorical information

as a statement, or predicate, which binds together other (so-called "lexical") predicates. Rhetorical predicates are more than "proleptic devices" or "connective vocabulary"; though different from lexical statements, they nevertheless are statements of a kind. Called "top-level" information by Bonnie Meyer (1975), these statements tell the reader, "There is an attributive relation between what you just read and what you are reading now," or "This is evidence for the above," or "This is a problem/solution relationship." For Meyer, the notion of rhetorical predicate is a helpful one, for as someone interested in reading comprehension, she wants a way to represent all the information that a reader should be expected to take away from a given passage. As teachers have guessed, and as Meyer's investigation (1980) has shown, it is the information such as "X is an example of Y" that student readers often miss.

Clearly the analysis by Grimes, Meyer, and others owes much to insights from generative grammar,[8] in spite of the fact that studies in generative grammar have focused on the sentence and not on larger units of discourse. Grimes and others have used the working assumption that a grammar should make explicit what is understood by a hearer or reader. They have also borrowed the practice of building models of particular pieces of language in order to show the complexity and the hierarchy of sentence relationships. These models, unlike traditional sentence diagrams, suggest that in a sentence like, "My arrival surprised her," there is not one but two statements (or predicates). There is a higher predicate, "something surprised her," and a lower one, "I arrived."

Cognitive psychologists such as Walter Kintsch (1975) have begun to investigate whether models of discourse structure based on this notion of complexity can predict the difficulty that people have with memory tasks involving language. Like Meyer, Kintsch has adopted the principle of rhetorical statements, though he terms them "propositions" in his analysis. He wants to know how many propositions there are in a given passage of text. Consider, for example, the following two sentences, in which there are eight:

> The Greeks loved beautiful art. When the Romans conquered the Greeks, they copied them, and thus learned to create beautiful art.

"Learned to create" is analyzed as two propositions, following the model of generative grammar's embedding principle, and "beautiful art" is analyzed as a proposition rather than a noun phrase. The relationships implied by "when" and "thus" are also analyzed as propositions: "something is WHEN something" and "something is the CONSEQUENCE of something." Thus, like the Meyer model, this one shows logical/rhetorical meaning as having statement value.

Besides Kintsch and Meyer, other model builders are now doing work in such areas as artificial intelligence and the analysis of children's memory for different types of discourse structure. In general, the work in model building is useful to the present study in suggesting how the insights of rhetoricians and the insights of linguists may be integrated. This work suggests (1) the interesting notion that rhetorical links have propositional, or statement, value; (2) that rhetorical predicates, if analyzed properly, can be counted, offering a clear and operational definition of complexity; (3) that rhetorical predicates can be typed, or labeled, allowing one to examine differences between types of coherence.

Before concluding our discussion in this chapter, it will be useful to define three more terms, all having to do with the "non-logical" element of coherence.

First, let us consider verbs, keeping in mind the structure of the apparently memorized text structure which conflicted in Rudy's case with the desired structure. The verbs of the memorized structure, called the "introductory form" in Chapter 3, were all statal, constituting by their very sameness a structural element. While the introductory form lacked logical elements such as cause/effect, as evidenced in part by the fact that whole sentences could change their position in the paragraph, it had the parallel-

ism of verbs to hold it together. Writing handbooks warn the writer to avoid an inconsistency of tenses within the paragraph, a warning that is misleading if taken to mean that tenses must never change. But it is true that the parallelism of verbs is something writers must consider, even exploit. While we are used to thinking of parallelism in terms of tense, might we not also look to the other structural features of verbs, such as the -ing or have aspect, to its modals, or to its statal or dynamic type?

In this connection Moffett (1968) has made the interesting observation that verb endings are clues to discourse structure. "It happened" and "it happens" belong to different discourse structures, the first presupposing a sequence of time-specific events, the second presupposing a world of routine, habitual, or generic events. The difference between "the blood flowed" and "the blood flows" is that the first suggests a specific fight or accident, fixed in time, while the second suggests a general event that goes on in the vague world of "now" but at no particular moment in that world. With respect to the statal/dynamic distinction, many linguists have noted the syntactic behavior of the two types of verbs. In describing states or conditions (like "She is happy"), one avoids the progressive -ing and manner adverbials. (No one says, "She is being happy" or "She is happy in a certain manner.") But in describing movement, change, or action, one is free to use both. Huddleston (1971) has observed in his study of scientific sentences that some verbs that are usually dynamic (e.g., "I can locate that book.") become statal ("The heart is located in the chest"). Note that it is hard to make the verb dynamic in such a context: "The heart is being located in the chest" or "The heart was carefully located in the chest" are strange. Very possibly the connection that Moffett pointed out between the discourse level and the features of verbs has other interesting implications for the study of text. We can anticipate that parallels in discourse level, reflected in these features, will constitute some, though not all, of the pattern of coherence.

Second, the coherence of the introductory form depended on the reader's understanding that every sentence had the same "topic." "Topic" and "comment" are terms used in the work on so-called "old" and "new" information.[8] The topic is part of the old information, that which is presumed familiar to the reader, and the comment is part of the new, or that which is presumed unfamiliar. "Topic" and "comment" refer respectively to (1) what the sentence is **about,** and (2) what is said about the topic. The topic of the sentence, "There are more things to do in a city," would depend on what had been said earlier. Suppose, for example, there were a sequence of sentences like the following:

I'd rather live in a city than on a farm. There are more things to do in the city.

The topic of the second sentence is a city, because this is what the speaker is talking about:

About a city—there are more things to do in it.

The sentence topic is already established in the discourse or already familiar to the reader. It receives low stress when the sentence is spoken aloud. It is not part of what is being asserted, but rather the thing about which the assertion is made.

Let us consider yet another example. The topic of a sentence might be "elephants." Thus in the sentence, "The most valuable part of the elephant is the ivory tusk," "elephant" is spoken softly, and the rest of the sentence is given more stress. However, the general topic might very well be "valuable part," like the skin of the leopard or the beefsteak of the steer. If so, one would read the sentence differently:

The most valuable part of the elephant is the ivory tusk.

The soft part, or the part not underlined above, is the topic. It is important to stress at this point that the topic should not be confused with grammatical subject. The topic

may or may not be the grammatical subject; it may or may not be near the front of the sentence; it may or may not be explicit.

One last term, the **characterizing reference,** is one included in the catalog of cohesive devices described by Halliday and Hasan (1976) (and mentioned as well by Shaughnessy). It is included here because it would seem to be especially useful to writers who wish to introduce what is actually new information in a form that makes it appear, to the reader, presupposed or old information. Where the topic of a sentence is "Mrs Robinson," let's say, the writer can maintain a link with this topic by the use of the referring word "she" or a repetition of "Mrs. Robinson," but he or she can use other words that maintain the cohesiveness just as well while also conveying the writer's attitude:

Look at Mrs. Robinson!
The silly old fool is climbing to the top of the tree.

Or the characterizing reference may be a means of placing a specific element, such as climbing a tree, into a larger class of **acts:**

Such an act is reprehensible.

In either case, the writer presents the characterization so as to make it seem part of the topic. Though Rudy used it neither in the introductory form nor in the structure he later adopted to fit the assignment, it would seem to be a device particularly well suited to writing that demands the explanation of complicated terms.

Notes

1. Janet Emig, **The Composing Processes of Twelfth Graders** (Urbana, Ill.: National Council of Teachers of English, 1971), p. 50.
2. See also James Moffett, **Teaching the Universe of Discourse** (New York: Houghton Mifflin, 1968); Ross Winterowd, **The Contemporary Writer: A Practical Rhetoric** (New York: Harcourt Brace Jovanovich, 1975); Richard Larson, "Sentences in Action: A Technique for Analyzing Paragraphs," **College Composition and Communication** 18 (February 1967):16-22; Richard Young, Alton Becker, and Kenneth Pike, **Rhetoric: Discovery and Change** (New York: Harcourt, Brace and World, 1970).
3. E.D. Hirsch, Jr., **The Philosophy of Composition** (Chicago: University of Chicago Press, 1977), p. 153.
4. Mina Shaughnessy, **Errors and Expectations** (New York: Oxford University Press, 1977), p. 34.
5. Especially Noam Chomsky, **Aspects of the Theory of Syntax** (Cambridge, Mass.: MIT Press, 1967).
6. Wallace Chafe, **Meaning and the Structure of Language** (Chicago: University of Chicago Press, 1970). Jeanette Gundel, "Role of Topic and Comment in Linguistic Theory," Ph.D. dissertation, University of Texas at Austin (reproduced by the Indiana University Linguistics Club, 1974).

CHAPTER 5

Predication Load: An Operational Definition of Coherence

Predication Load

In this chapter I will argue that the difficulty level of the pre-medical writing task was related to information **type.** I assume that, both explicitly and implicitly, the assignment dictated the kinds of information to be used. If the writing did not convey the right combination—and the right kind—of information, it was off the point or irrelevant.

To achieve both relevance and coherence, the writers had to use the **content** type required by the assignment in combination with the needed **relational** type. What this meant for the individual surface sentence was that it had to be a combination of types, or to have—in most cases—more than one type of sentence underlying the surface. (I will use the word "type" to refer to **relational** and **content** information, the word "strands" to refer to various kinds of content information.)

Each underlying sentence communicating information is termed a **predication.** The number of predications and the number of types or strands of predication within a sentence were a useful way of measuring the cognitive dimension of the writing task. These numbers constituted the load which the writer somehow had to handle. The two measures are both parts of what will be called the **load of predications.**

Information Types

There were, for every biology writing exercises, three kinds of information required. First, there was a strand of information usually about the structure of the body, such as where elements were "found" or "located," what they were "composed of," what they "comprised," what they "formed," what they "had," how they were "arranged," what color or shape they "were," what they "needed" or "required." Such information is characterized by the syntactic properties of the statal verbs in quotes above and also by the characteristic sentence topic, "the body." I will refer to this as **body structure information.**

Second, there was an information strand about what the body **did,** whether it—or parts of it—"contracted," "squeezed," "inhaled," "flowed," "diffused," and so on. The topic is "the body"; the verbs are dynamic. This information will be referred to as **body function information.**

Information of the **relational** type typically showed how predications of the two content strands were related to each other by comparison, cause, specification, and generalization. A body structure predication such as:

Skeletal muscle cells are spindled-shaped.

and a body function predication such as:

Skeletal muscles contract rapidly.

could be related to each other by a relational predication:

> The spindle shape of the skeletal muscle cell allows for rapid contraction of the muscle.

The phrase "allows for" has within it the relational idea of CAUSE, since in some way the spindle shape of the cell causes the muscle to contract rapidly. Neither a logician nor a biologist would go along with this definition of "cause," since the spindle shape does not really **do** anything—it just **is**—and so one finds it hard to imagine the shape causing something. Besides, it is not a complete cause, just part of the cause. But to call it CAUSE helps to simplify the grammatical explanation, since CAUSE can serve as the general term for the category including **purposes, reasons, goals, results, effects,** and **conditions,** all of them relationship words indicating a non-accidental connection between earlier and later events. Some words, like "prevent," "inhibit," or "generate," have within them the notion of CAUSE but mean something else as well. "Prevent," for example, means something like "do-something-to-CAUSE-not-to-happen."

The notion of purpose, which is part of CAUSE in this analysis, can be conveyed in a number of ways, as with the phrase "in order to" in the following ungrammatical sentence written by Jose:

> They are supplementary with each other in order to keep life continues.

or very directly, as in this sentence (also written by Jose):

> The primary function of the immune system is to protect the body from infections.

Similarly, notions of comparison (either sameness or difference) were expressed by Jose in a variety of ways. In the sentence below, for example, the relational predication is the predication of the surface sentence:

> The two systems of the body have different purposes and functions.

In the following sentences the notion of comparison is less direct, as in this one, which contrasts with the sentence above:

> But one way or the other they are supplementary with each other . . .

The word "but" signals the intended contrastive relationship (called here COMPARE): "They are different but they are supplementary . . ." Comparison relationships were also shown by means of single-word adjectives:

> There are four proteins in the muscle cell. The major one of the four . . .

where the words "the major one" say, in effect, that one of the proteins is major and the rest are minor. The present analysis will show this sentence as containing the underlying predication:

> one protein COMPARE ("is different from") other proteins

The sequence below (again written by Jose), grammatically faulty as it is, expresses two relationships. One is the COMPARE idea in the second sentence ("Some are good and some are bad."); the other is the specifying one expressed by the second sentence vis-a-vis the first. ("Not all foods are good. Some are infectious.") Such a relationship will be labeled SPECIFY.

> Not all the foods that are taken into the body are good. These foods contain good materials which be absorpted and some are infectious to the body which we will refer them as antigens.

The lead-in sentence, "The digestive system has immune system components," was specified by Jose in the following way:

> Some of the immune system barriers which work in connection with or parts of the digestive system are the glands, mucus, and sometime the spleen.

and also in this way:

> The mucus contains antibodies which fight antigens and help to lubricate the foods.

These last two surface sentences are shown in the analysis as having a component deep-structure sentence which makes explicit the relationship:

> (something) SPECIFY (something else)

Three kinds of relational predications, then, are CAUSE, COMPARE, and SPECIFY. A fourth is GENERALIZE, used more frequently by Richard than by the others and commonly marked by him with the word "all:" "All of these are physical barriers."

Illustration. The passage below shows how the writer is required to, or manages to, handle quite a heavy load of predications. The lead-in sentence, although it contains just a single type of information and a single predication, must be followed by sentences which are complex informationally. The lead-in sentence, "The digestive system has immune system components," directs the writer not only to list some of these components but also to demonstrate their immune function, or in other words to show that they fight off harmful bacteria. To communicate these ideas requires two strands of information and two different kinds of verbs. Having components is body-structure information; fighting bacteria is body-function information. In addition, the writer will have to show that the components he or she lists are meant to specify the general concept "immune system components," and so he or she must provide a statement that shows the reader the SPECIFY relationship.

Passage/Analysis 1

Passage 1

(1) The digestive system has immune system components. (2) The surface layer of the alimentary canal, for example, has tight junctions between its cells so that no foreign material can enter via this route. (3) There are also cells among the epithelial cells which secrete mucus, trapping the invaders, and ciliated cells that move the invaders out to be swallowed and digested, or secreted. (4) All of these are physical barriers.

Analysis 1

	No. of types and strands	No. of predications		
1.	1	1	The digestive system has immune system components.	
2.	3	4	a. relational	Sentence 2 SPECIFY Sentence 1 ("for example")

			b. structure	The surface layer of the alimentary canal has . . .*
			c. relational	Sentence 2b CAUSE Sentence 2d ("so")
			d. function	No foreign material can enter via this route
3.	3	9	a. relational	Sentence 3 SPECIFY Sentence 1
			b. relational	Sentence 3 COMPARE Sentence 2 ("also" conveys "is like")
			c. structure	There are cells among the epithelial cells
			d. function	They secrete mucus
			e. function	They trap the invaders
			f. structure	There are ciliated cells
			g. function	They move the invaders out
			h. relational	Sentence 3g CAUSE Sentence 3i
			i. function	The body swallows, digests, or secretes them
4.	2	2	a. relational	Sentences 2 and 3 GENERALIZE Sentence 4 ("all of these")
			b. structure	These are called physical barriers

Number of sentences with relational information: 3 out of 3, 100% (the first sentence is not counted).
Number of relational predications: 6 in 3 sentences, or 2.00 per sentence.
Average number of predications per sentence: 5.0.

*Ellipsis, as in Sentence 2b, indicates deletion of material because of space considerations in this and all following analyses.

The second and third sentences SPECIFY the first as well as the fourth sentences. They show examples of immune components in the digestive system (Sentence 1), as well as examples of physical barriers (Sentence 4). The third sentence is shown to be related not only to the first, by example, but also to the second by comparison. That is, Sentences 2 and 3 are similar because they bear the same relationship to Sentence 1.

With the exception of Sentence 3a, where the relation is implicit, the relational predications in this passage are all conveyed by single words ("also" and "all") or phrases ("for example"). In another passage, however, these predications might have surfaced in the main verbs ("Muscle cells are examples of . . ."), and thus more obviously shown themselves to be predications.

What is crucial is that the relational predications occur frequently and that they are combined with information of other types. To convey the body structure information that "the surface layer of the alimentary canal has tight junctions" requires in itself a small feat of memory; some students took several sentences just to describe the structure of the layers of the long digestive tube. To convey both this information and the example relationship between this sentence and the first sentence is thus a double task. And to make the task even more complicated, there is within the sentence a causal relationship between the tight junctions and the inability of the foreign material to enter. The information that the tight junctions kept out foreign material was crucial, for it demonstrated that the structural design of the cell was indeed related to its immune function. Without this link, the sentence as a whole would not have served to mark the example relation. But what makes the sentence complicated is also what makes it relevant—the combination of relational predictions and strands of content information.

Also significant, though less so, is simply the number of predications per sentence—in this case, an average of five per sentence. Sentence 3 alone has nine predications, an unusually high number and not necessarily an indicator of higher quality than the other sentences. But an average of at least three or four predications per sentence—

while less crucial than the presence of relational information—seems to characterize not only this passage but other well-integrated material in the study.

Incoherence: a sample passage/analysis. The analysis is revealing for what it shows about student writing which is incoherent or very nearly so. The 13 sentences in Passage 2 and the analysis that follows will illustrate the coherence problems in Jose's writing. Actually the student is confused about what he is to do. Talk about any sort of relationship between the digestive and immune systems? Talk mainly about the immune system? Talk first about one and then the other? For this student from Micronesia, the first sentence did not direct him, as it did most of the group, to name immune components located in the digestive system and to show how they work.

Passage/Analysis 2: Jose, Early Sample

Passage 2

(1) The digestive system has immune system components. (2) These two systems of the body have different purposes and functions. (3) But one way or the other they are supplementary with each other in order to keep life continues. (4) The primary function of the immune system is to protect the body from infections and the digestive system is for the digestion of materials and absorption of nutrients. (5) When foods are taken into the body, they have to be digested, metabolised, absorpted, or discharged. (6) Not all the foods that are taken into the body are good. (7) These foods contain good materials which be absorpted and some are infectious to the body which we will refer them as antigens. (8) The immune system produces antibodies which kill those antigens to protect the body. (9) The digestive system is composed of the alimentary canal plus its derivatives and accessory organs. (10) Some of the immune system barriers which work in conjunction with or parts of the digestive systems are the glands, mucus, and sometime the spleen. (11) These glands and mucus membrane play an important part in the digestive system. (12) The glands secrete the hormones, mucus, and other components which help to initiate, run, and complete the digestive system function. (13) The mucus contains antibodies which fight antigens and help to lubricate the foods.

Analysis 2

	No. of types and strands	No. of predications		
1.	lead-in			The digestive system has immune . . .
2.	1	1	a. relational	These two systems . . . have different purposes . . .
3.	1	2	a. relational	They COMPARE ("are supplementary with each other")
			b. relational	Sentence 3a CAUSE keep life continues

4A.	2	2	a. relational	The immune system CAUSE Sentence 4Ab
			b. function	The body is protected
4B.	2	2	a. relational	The digestive sysem CAUSE Sentence 4Bb
			b. function	The body digests materials and absorbs nutrients
5.	2	3	a. function	The body takes in food
			b. function	The body must digest, metabolise, absorb it
6.	1	1	a. deviant	Not all the food are good
7.	3	6	a. deviant	Foods contain good materials
			b. function	The body absorbs these
			c. structure	Some are infectious to the body
			d. structure	They are called antigens
			e. relational	Sentence 7a COMPARE Sentence 7c
			f. relational	Sentence 7 SPECIFY Sentence 6
8.	2	4	a. function	The immune system produces antibodies
			b. function	The antibodies kill those antigens
			c. relational	Sentence 8a CAUSE 8b
			d. relational	Sentence 8 SPECIFY Sentence 4A
9.	1	1	a. structure	The digestive system is composed of the . . .
10.	2	2	a. structure	Some of the barriers . . . are the glands, mucus . . .
			b. relational	Sentence 10 SPECIFY Sentence 1
11.	1	1	a. function	These glands and mucus membrane play an important . . .
12.	1	2	a. function	The glands secrete the hormones, mucus, and . . .
			b. function	They help to initiate, run, and complete . . .
13.	2	2	a. structure	The mucus contains antibodies
			b. function	The antibodies fight antigens
			c. function	The antibodies help to lubricate the foods

Number of sentences with relational information: 7 out of 13, or 54% of the sentences. (Sentence 1, the lead-in, is not counted.)
Number of relational predications: 10 in 13 sentences, or .77 per sentence.
Average number of predications per sentence: 28 in 13 sentences, or 2.15 per sentence.

Not only does the passage lack the sense of direction intended by the instructor, it also lacks any sense of direction imposed by the student. This is revealed by the lack of relational information in Sentences 9, 11, 12, and 13. Until Sentence 9 the line of thought, although a bit slow in being established, nevertheless conveys the messages: The immune system protects the body, and the digestive system absorbs the food. Not everything taken in by the digestive system is good. There are some bad things, or antigens. So the immune system produces antibodies, and the antibodies kill the antigens.

Until Sentence 9, the sentences generally carry the required types of information, though Sentences 6 and 7, introducing "food" as a sentence topic, do not qualify as any of the three types and are momentarily puzzling to the reader. But Sentence 9 is information of only one type—body-structure information—and thus does not meet the relevance requirement. For the reader who can ignore this sentence, Sentence 10 is readable because it specifies the general concept of Sentence 1. But many readers

cannot ignore Sentence 9, and they seek a relationship between Sentences 9 and 10. A break similar to the one caused by the irrelevance of Sentence 9 occurs at Sentences 11 and 12. Here again, there is only one type of information. By the time readers reach what would have been relevant information in Sentence 13 (the antibodies fighting the antigens), they are unable to link this with the earlier information on the topic because the break has been too long. In sum, the reader finds the passage incoherent.

Questions and Answers

There are now a number of clarifications to make with regard to the analysis, which I have chosen to present in the form of questions.

Are the relational predications in this analysis always grammatically combined with other predications? (Recall Meyer's point that rhetorical predicates were only intersentential; they operated only as predicates connecting other predicates.) The answer, as far as my data suggests, is that relational predicates can occur uncombined, as in: "This one is different from that one" or "The aorta is an example."

How many kinds of relational predicates are there? The answer in this case reflects the narrowness of the data base for the present study. There were four kinds of relational predicates—CAUSE, COMPARE, SPECIFY, and GENERALIZE—which enabled me to account for the coherence that I perceived intuitively on first reading the essays. Each of these kinds, however, is broadly inclusive. CAUSE, as shown earlier, includes a number of relationships, such as "purpose," that are listed separately in the rhetorical studies in the literature. COMPARE includes notions such as "part-to-whole" and "enumeration," while SPECIFY includes both "illustration" and "elaboration." SPECIFY and GENERALIZE are seen as different kinds of relational predicates, not just different manifestations of the same kind, since there were clear examples in the data that argued for this interpretation. In sum, the notion of relational predication is defined here quite narrowly and does not include other elements such as time and space connections. These two links were obviously part of the total mechanism of coherence, but they were present just as much in the essays perceived as incoherent as in the essays perceived as coherent.

Are the predications the same as the classic transformational grammar deep-structure sentences, and, if so, how deep is deep? How does the analyst decide what constitutes a predication? The analysis is informed by transformational analysis and is similar to models built by those doing research in cognitive psychology. At the same time, however, it reflects judgements made by the investigator—that is, by me—about the way the writers actually used the information.

Let us look at this problem in more detail. Recall the example sentence used earlier:

The major protein is actin.

In my discussion I said that the words "the major" in the surface sentence are the remnants of a relational predication:

One protein COMPARE ["is different from"] other proteins

There were good reasons to argue for the existence of an abstract relational sentence, for it was clear that the writer was differentiating between the one protein that was major and those that were not. But in a good deal of writing, there is no sense of differentiating. This is quite evident, for instance, in the sentence cited earlier from the writing of Jose:

The primary function of the immune system is to protect the body . . .

What other functions does the immune system have? Even if there are any, it is clear from the context that the writer is not using the word "primary" to say that one function is primary and the others are less than primary. There simply is no sense of com-

parison in the sentence. Thus, for our analysis, there is no corresponding relational predication.

So it is for other cases as well. If no relational meaning is conveyed, there is no corresponding predication. Isolated surface sentences may be deceiving. It is only in the context of other sentences that one can know whether relationships are being expressed.

In a context like the following, there is clearly a sense in the third sentence of a relational predication: "The two types of response differ."

> (1) The digestive system has immune system components. (2) It involves both the specific and non-specific immune response. (3) The difference between the two types of response is that . . .

In this case the word "difference" can be said to express a COMPARE relation.

The analysis in such cases recalls the observations made by both Halliday/Hasan and Mina Shaughnessy that extra information can be conveyed in constructions that seem to have only a referring function. In the pair of sentences,

> Look at Mrs. Robinson. The foolish old woman is climbing to the top of the tree.

the referring phrase, "the foolish old woman," communicates the speaker's opinion of both the woman and her age. Such constructions are represented in the present analysis as predications only when they convey extra information of this kind. Thus, the number of **predications** is intended to reflect the integrating and grammatical processing actually done by the student. In this sense, the results presented here are an analysis of **process.** The existence of a number of predications underlying the surface sentence indicates that the student, in writing the sentence, has tried to integrate the material. He or she may have constructed the sentence so that some of the assertions were implicit and others explicit though expressed in a number of ways. But whatever the mode of expression, he or she has been working, in some fashion, with a quantity of relational and content material. The label "predication **load**" seems apt, for the writer must carry a burden of relational and content information.

Example of Predication Load

One last example sentence, broken down into component predications, will illustrate the point that the coherent writer, in writing prose demanded by the biology class, was required to pull together predications of more than one type:

> The difference between the two types of response is that the non-specific response reacts against any foreign molecule and prior exposure to the foreign molecule is not needed for the defense mechanism to work.

In this case there are three relational predications, one of them foregrounded by the writer:

> The difference . . . is . . .

A second one, that this sentence SPECIFIES the preceding one, is implicit. A third is a CAUSE predicate—something (is not needed) to CAUSE the defense mechanism to work. This predication is conveyed by the purpose word, "for," in the phrase, "for the defense mechanism to work." In addition to the three relational predications, there are two body function predications:

> The non-specific response reacts against any foreign molecule.

and

> This defense system works.

Additionally, there is one predication about the state or condition of the body:

Prior exposure [by the body] to the foreign molecule is not needed.

Predication Loads for Six Students

The hypothesis of information types and strands describes and accounts for a variety of problems with coherence in the writing of the pre-medical group, and it provides a means for comparing one piece of writing with another. The precise indicators are:

1. **the proportion of sentences that contain at least one relational predication** (This proportion also reveals the proportion that lacks any such predication, for if 75% contain at least one, then 25% contain none.)
2. **the average number of relational predications per sentence**
3. **the overall average number of predications per sentence**

What does each of these measures indicate?

In regard to (1) above, the fact that 100% of the sentences in a given piece of writing contained relational information was characteristic of all writing judged coherent. This was a good sign. It indicated that probably the writing was coherent (though not necessarily so, since the writing had to meet other conditions as well). Writing that did **not** have relational information in every sentence failed to meet the coherence requirements.

For (2), the average number of relational predications per sentence generally was interesting when the number was smaller than 1.00 per sentence. In other words, the difference between .12 and .75 was a revealing difference, indicating that the writer of the second piece (the .75) was probably making an attempt to integrate. An average of 1.00 was a borderline case. The well-integrated prose ranged from 1.50 on up, though averages higher than 1.50 did not indicate increasingly greater coherence.

Finally, a fairly high average number of predications, say 3.00 to 4.00, was characteristic of the passages judged coherent, though there were sentences with just two predications that were relevant.

The tables which follow are actually a set of summary statements about the coherence of passages written by six students. Two sets of passages were examined—those produced on March 2 and April 27. (These passages, together with corresponding sentence analyses, can be found in Appendix C.) The tables correspond to the three measures listed above. An important point to remember when examining the data presented in the tables is that incoherence is a function of low predication load, and that, roughly speaking, it is reflected by low scores as shown in these tables.

For Rudy, the later sample is much improved over the early samples. (In his case there are two samples of early work.) The two pieces of early writing are both considerably below the point of having relational information in every sentence, but the later writing does show relational information in every sentence (Table 5) and an average of 1.14 relational predications per sentence (Table 6). The later sample shows an average 2.86 predications per sentence (Table 7) compared with the very low 1.87 and 1.25 for the earlier samples. The writing of Tomas follows a similar pattern.

The coherence of Jose's writing, however, shows little real difference from one sample to the next. Numerically speaking, both his early and late samples fail to meet the required 100% for Table 5: one shows 54% and the other 37%. the same is true for Table 6: both samples are below the required 1.00. Though the overall number of predications (Table 7) is adequate for both samples, something else was lacking, for the passages are incoherent. In short, the tables suggest that Jose used a good deal of body structure and function information—which meant that his sentences were complex—but that he failed to provide enough relational information. His writing is a little different from the early samples of Rudy and Tomas, for theirs simply showed an inadequate load—too little complexity, too little load—while his lacked only relational information. He differs from them in another way: they were apparently able to change, but he could not.

Table 5

Percentage of Sentences Containing Relational Information

	Early Sample	Later Sample
Rudy (sample 1)	37	100
(sample 2)	12	
Tomas	20	100
Carol	100	75
Tua	86	100
Richard	100	100
Jose	54	37

Table 6

Number of Relational Predications Per Sentence

	Early Sample	Later Sample
Rudy (sample 1)	.62	1.14
(sample 2)	.12	
Tomas	.30	1.50
Carol	2.20	1.50
Tua	1.28	1.43
Richard	2.00	1.50
Jose	.77	.37

Table 7

Number of Predications Per Sentence

	Early Sample	Later Sample
Rudy (sample 1)	1.87	2.86
(sample 2)	1.25	
Tomas	1.50	4.25
Carol	4.60	3.25
Tua	3.14	3.00
Richard	4.16	3.70
Jose	2.15	2.37

As for Richard and Carol, their writing meets the requirements for the first sample, although for the second one Carol's writing shows a slight decline. In this second sample Carol uses relational predications in only 75% of her sentences (Table 5), whereas

coherence, according to our findings, demands 100% usage. As for Richard, the early and later samples show predication loads that are quite acceptably high. This fits with the impression given by his writing that he had successfully struggled with the information, had it well under control, and could handle it in whatever combination was required by the assignment.

Those who had relational predications in every sentence generally had high levels of predications as well. (See, for example, the data on Carol and Richard in Tables 5 and 7 respectively.) But it was possible to have a high level of predications and **not** have relational information in every sentence. Such a combination produced incoherence (see the data for Jose in these tables). This example supports the point made earlier that a large number of predications was usually characteristic of coherent prose but did not necessarily create coherent prose. That is, it was not a sufficient condition for coherence.

This example supports the point made earlier that a large number of predications was usually characteristic of coherent prose but did not necessarily create coherent prose. That is, it was not a sufficient condition for coherence.

As for the very high predication loads, notice (Table 7) that both Carol (early) and Tomas (late) have a very high average number of predications (4.60 and 4.25). This fact indeed made for complexity of meaning but did not in itself make for such dense prose that it was difficult to follow. Nor did it make for a connectedness that was necessarily better than the average "good" predication loads of 3.00 to 4.00.

Rudy's early work is represented by two samples. One is a chunk that imitates the introductory format. The other is a hodge-podge that is actually further down the developmental line, for the chunks are shorter and the attempt is made now and then to pick up on all three types of information at once. The two samples of early work are included because the chunk style shown by Sample 2 is an extreme form and not representative of Rudy's other early work.

There is, in fact, no claim that these passages accurately represent the quality of the work the student was doing at that time of the semester. The number of sentences, for one thing, is not very large and not every essay was analyzed. For Rudy, Richard, and Jose the passages are, in fact, probably quite representative, but there was nothing in the design of the study to insure that they were. The fact that the later sample for Carol is not quite as good as the earlier sample probably does not indicate a decline over time but simply that her performance was erratic. Likewise, the later work of Tomas was not always as coherent as his late sample indicates. The claim is not that the samples are representative of the student's general work, nor that these particular students represent the general population of college pre-medical students, but rather that the figures in the tables accurately reflect important aspects of coherence.

As for Tua, his relatively high marks for coherence (86% and 100% on Table 5) are perhaps misleading, for his writing lacked adequate content. I said earlier (in Chapter 3) that it was easy for students in the low group to be coherent. If Tua were to follow the pattern of Rudy and Tomas, his scores for coherence might well go down as he labored with an extra load of memorized information.

Predication load in a complex, professionally written passage. The students' task was demanding because two types of information, relational and content, had to be integrated. But their task was not as complex as it might have been. The content information required for the assignment was limited by the nature of their lecture and textbook material to just two patterns—roughly speaking, the body does and the body is. In other writing situations, the writer may feel compelled to introduce many more such strands, each one characterized by a topic and certain verb features. Presumably the writer can introduce new strands as he or she feels the need for them, but will also feel the need to repeat at least some of them in order to create a pattern. For the writer who has introduced a number of strands and maintains several of them at once, the

writing task may increase in complexity. By way of illustration, I have chosen a complex passage from **The Science of Movement** by Tricker and Tricker (see p. 51). The paragraph covers much of the same ground covered by Rudy and the others on the topic of muscle contraction. Here again one finds information about the structure and appearance of the cell—the bands, rods, and component pieces. Here also is information about movement and function—sliding, moving, and contracting. But added to these are other strands of information about (1) scientists and what they have done ("observed," "seen," "described," "shown," "identified," and "found"), (2) scientists and what their attitudes have been (they "were reluctant," they "would have preferred"), (3) a theory and what it "provides for," "is," or "suggests," and (4) the author's evaluations. Add to these the required relational type of information, and the total is quite a number of kinds of information, most of which are carried by the writer through a series of sentences. Again these various strands of content information are sometimes differentiated by statal and dynamic verb types, and in addition they sometimes require different tenses and verbal aspects. The tense variable is something that did not arise for the pre-medical students because the two strands of content information and the relational information required the same tense, the timeless present (cells live, muscles are, etc.). But notice the variety of verb forms required by the author here.

Information Types and Strands		Verb Type	Aspects/Tenses Used
1. Relational		statal	timeless present (one occurrence of the past)
2. Content[1]			
Strand 1:	Scientists do things	dynamic	the "have" aspect past tense present tense (this used only for "Reviews are given by Huxley"—a literary convention)
Strand 2:	Scientists had attitudes or capabilities	statal	past
Strand 3:	The body does	dynamic	timeless present
Strand 4:	The body is	statal	timeless present
Strand 5:	The theory is/does	statal/dynamic	timeless present
Strand 6:	The author evaluates	statal	timeless present

Not every strand occurs in every sentence, but every strand does occur with fair frequency, and the relational occurs in every sentence. Inclusion of information about the attitudes and actions of the scientists would, in particular, add to the writer's difficulties, for this information requires a time-fixed verb (or "punctual" verb) instead of a verb of the timeless present. There are times when the verb has been deleted in the surface sentence, and such deletion simplifies matters somewhat. But the essential difficulty remains. How is one to talk about the sliding theory and what it says while, for purposes of accuracy, the author must also say what scientists did and have done, what they felt, what he feels, and what the body is like and what it does, while also conveying the relationships among all these pieces of information?

The writing of this paragraph requires the writer to consider six strands of content information as well as the relational information. The strands are differentiated according to topic, type of verb, and various constraints or options regarding tense and aspect. Relational information is contained in every sentence in combination with other types. While not every strand is contained in every sentence, the writer still manages to integrate an astonishing number of them in some of the sentences. Only the first, the last, and one other sentence are relatively simple, including only one

strand of content information. The other sentences contain three or four. Thus, the predication load—or the degree of integration—is very high indeed.

The significance of this integration, in terms of coherence and meaning, is that the readers sense the interplay of the various types of information. Almost simultaneously they read about what scientists have done, what they thought, what the authors think, what the body is, what the body does, and various theories about muscle action. At least some of the strands the writer introduces must be kept going for several sentences (not necessarily, but often, consecutive sentences). In this regard it is interesting that the information strand, "actions of scientists," occurs in Sentences 1-3, 5-8, 10, 12, and 13. "Attitudes of scientists" occurs in Sentences 8 and 9. The "structure of the body" occurs in Sentences 2-6. The "function of the body" occurs—but not so consecutively—in Sentences 2, 7, and 11. The "theory" occurs in Sentences 8-12.

Passage/Analysis 3: A Professional Sample

Passage 3 (from Tricker and Tricker, **The Science of Movement**[2])

(1) Various subdivisions of the striations have since been identified, of which the A, Z, I, and H are the most important. (2) In 1954, A. F. Huxley was able to show by stimulation with microelectrodes that the A bands move together on contraction of the muscle, reducing the width of the I band. (3) The advent of the electron microscope allowed greater powers of resolution, and further striking patterns were observed. (4) The cross-section is a regular pattern of dots which the longitudinal section shows to be bundles of rods. (5) The rods are of two types which have been identified with the two types of protein, actin and myosin, found in muscles. (6) The A band was found to be made of myosin, while the actin was present in all but the H band. (7) The sliding of one set of rods into the other accounts for both the contraction of muscle and the light microscope observations on the striations. (8) Some biologists were reluctant to accept this explanation, for no such mechanism had been encountered before in connection with living mechanisms. (9) Many observers would have preferred some coiling arrangement. (10) However, the sliding theory resulting from the elegant work of A. F. Huxley, R. Niedegerke, H. E. Huxley, and J. Hanson provides a very economical explanation of the observations. (11) It makes no pretense at describing how the contraction is made forceful, i.e., how the energy-rich chemicals convert their energy into a physical pull, but the ideas of some easily reversible bonding between actin and myosin may prove to be the answer. (12) Such bridges are, in fact, seen under the electron microscope. (13) More detailed reviews are given by H. E. Huxley, **Sci. American,** December 1965, and D. S. Smith, **Sci. Am.**, June 1965.

Analysis 3

	No. of types and strands	No. of predications		
1.	2	2	a. Strand 1	The striations have been identified . . .
			b. Strand 6	These are most important

2.	3	7	a. Relational	Sentence 2 SPECIFY Sentence 1
			b. Strand 1	Huxley was able to show . . .
			c. Strand 1	He stimulated with microelectrodes . . .
			d. Strand 3	The A bands move together
			e. Strand 3	The muscles contract
			f. Relational	Sentence 2d, e CAUSE Sentence 2g
			g. Strand 3	The width of the band reduces . . .
3.	4	6	a. Strand 0	The electron microscope (came into being)
			b. Strand 1	It allows (to scientists) greater powers . . .
			c. Relational	Sentence 3a CAUSE Sentence 3b
			d. Strand 4	(the muscles showed) striking patterns
			e. Strand 1	These were observed
			f. Relational	Sentence 3 COMPARE Sentence 1, 2 ("further")
4.	2	3	a. Strand 4	The cross section is a regular pattern of dots
			b. Strand 4	The longitudinal section (is) a bundle of rods
			c. Relational	Sentence 4 SPECIFY noun phrase in Sentence 3
5.	3	4	a. Strand 4	The rods are of two types
			b. Strand 1	These have been identified as the two types of . . .
			c. Strand 4	These are actin and myosin, found in muscles
			d. Relational	Sentence 5 SPECIFY noun phrase in Sentence 4
6.	3	3	a. Strand 1	(Someone) found . . .
			b. Strand 4	The A band is made of myosin . . .
			c. Strand 4	Actin is present in all but the H band
			d. Relational	Sentence 6 SPECIFY noun phrase in Sentence 3
7.	3	4	a. Strand 3	One set of rods slides into another
			b. Relational	Sentence 7a CAUSE Sentence 7c, d
			c. Strand 3	The muscles contract
			d. Strand 1	Striations by light microscope were observed . . .
8.	4	5	a. Strand 2	Some biologists were reluctant to accept
			b. Strand 5	This (was) explanation
			c. Relational	Sentences 8d, e CAUSE Sentences a, b ("for")
			d. Strand 5	(This was) mechanism in connection with living . . .
			e. Strand 1	No such mechanism had been encountered
9.	3	3	a. Relational	Sentence 9 COMPARE Sentence 7
			b. Strand 2	Many observers would have preferred
			c. Strand 5	(The muscles) arranged in coil
10.	4	6	a. Relational	Sentence 10 CONTRAST Sentence 9
			b. Strand 5	The sliding theory provides an explanation
			c. Strand 7	The explanation is economical
			d. Strand 1	Huxley, etc. (did) work
			e. Strand 7	The work was elegant
			f. Relational	Sentence d CAUSE Sliding theory ("resulting")
11.	3	9	a. Strand 5	It makes no pretense at describing how
			b. Strand 3	The contraction (is) forceful
			c. Relational	(Something) CAUSE Sentence 11b ("is made")
			d. Relational	Sentence 11e SPECIFY Sentence b, c
			e. Strand 3	The energy-rich chemicals convert their energy . . .
			f. Relational	Sentence g, h CONTRAST Sentence 11a ("but")

			g. Strand 7	Sentence 11h may prove to be the answer
			h. Strand 3	Bonds between actin and myosin easily reverse
			i. Relational	Sentences a, b, c, d, e CAUSE Sentence 10
12.	3	3	a. Strand 5	(These are) bridges
			b. Strand 1	These are seen under the electron microscope
			c. Relational	Sentences 12a, b SPECIFY Sentence 11 ("in fact")
13.	2	2	a. Relational	Sentence 13 COMPARE above sentences ("more")
			b. Strand 1	Reviews are given by Huxley, Smith, etc.

Number of sentences with relational information: 12 out of 12, 100%.
(The first sentence is not counted.)
Number of relational predications per sentence: 1.50.
Average number of predications per sentence: 4.58.

Student Response to Very High Predication Load

No one can know what the students in the study would have done if an assignment had demanded integration of this magnitude. Yet the evidence offered by their writing suggests three possibilities.

The first is that they might not have had enough material at hand to integrate. Lack of content was the problem of several essays written by those in the low group (though not the passage on p. 43 of this chapter). A common response was to write relevant remarks without supporting detail.

The second possibility is that the students would avoid integration. Like Rudy and Tomas did in their early essays, the students would simply deal with one, perhaps two, strands of content information, but not the required combination of content and relational types. In fact, in another set of circumstances the requirement might have been different, allowing the student to deal with fewer types at a time. To tell the same story told by Tricker and Tricker, one could have begun with information about the way muscle cells look (structure, striations, component proteins, etc.), continued with the way they work (sliding rods, attachment, release), explained that this is a theory and that there are competing theories, narrated a chronological series of discoveries by scientists, and concluded with the attitudes of the scientists toward one theory or another and their final preference (as well as the author's) for the sliding theory. The reason why such a strategy of separation—separating one type of information from another—would not work for the pre-medical students is that the constraints of the assignment, as shown in the lead-in sentence, did not allow it. These constraints had, in fact, been deliberately imposed so as to force integration.

The result of trying to separate the information was the chuck-style of writing. When the student, faced with the task of describing the effect of smooth muscle action on cardiac output, instead described the structure of smooth muscles, he produced an irrelevant chunk. The material itself was not irrelevant, but the task assumed by the student was not the assigned task. Instead of saying how the action of the smooth muscle made the heart put out more or less blood, Rudy described smooth muscle and then the action of the heart without focusing on the connection between the two pieces of description.

A third possibility is that students would successfully integrate the required types of information but in the process would produce sentences faulty in grammar and style. The writing of Jose, where it carried predicate load sufficient for relevance, showed sentences with grammatical faults of one kind or another. The same was true for other students. How, when, and where such faults occurred will be the topic of the next chapter.

Notes

1. There is one other strand of information that does not fit the categories—the information that the electron microscope came into being—but this type of information, labeled Strand 0, occurs only once.
2. R.A.R. Tricker and B.J.K. Tricker, **The Science of Movement** (London: Mills and Boon, 1966), p. 72.

CHAPTER 6

The Relationship Between High Predication Load & Grammatical Errors

As was noted earlier in the work of Rudy (Chapter 3), when the students carried high predication loads in single sentences, they tended to make grammatical errors. For instance, Rudy had trouble with sentence grammar as he was explaining that the existence of small structures in the digestive and respiratory tracts created a large surface area, which in turn allowed for the efficient exchange of gases or nutrients. The specific grammatical structure that gave him trouble was:

The more (something), the more (something)

This sentence is understandably difficult, for it is the expression of a very abstract notion: that one comparative relationship is causally related to another comparative relationship. It is logical to assume that Rudy lacked practice with this kind of structure.

The error Rudy made in this grammatical structure is like a spelling mistake made by someone using a new word or like the errors made by foreigners with such things as verb placement in indirect questions:

Wrong: I wonder what is the question.
Right: I wonder what the question is.

or the placement of the auxiliary in negative constructions such as:

Wrong: Not only the kidney can absorb . . .
Right: Not only can the kidney absorb . . .

Wrong: {Not unless / Only when} the kidney absorbs, the body can . . .

Right: {Not unless / Only when} the kidney absorbs, can the body . . .

These are developmental errors, meaning that their appearance signals some sort of progress in the achievement of an overall aim. When the child says "see'd" instead of "saw," the error in itself is thought to be less serious than the potential problem of never learning the rule for past-tense formation. The small error is tolerated for the sake of the larger learning. In the case of the writing student, the larger learning is the ability to consider the relationship implied by the "not unless" and "only when" or the different one implied by "not only."

Unfortunately, the present study suggests nothing new about ways of dealing with such errors. Is it best to leave them uncorrected on the assumption that the writer will

somehow grow out of them just as children grow out of their grammatical mistakes? Should the writer be corrected on the assumption that adult language learners may never grow out of their errors without conscious learning and self-correction? Indeed, we cannot be sure that the sentence-level errors made by Rudy and others in the group are in fact developmental, given the small size of the data base.

What the study does show are several interesting patterns with regard to the errors. It also shows apparent gaps in the students' use of language to express relationships. In this chapter the problems encountered by the students will be listed and described under two headings: (1) Problems with the relational form and (2) problems with the non-relational form. (It should be kept in mind that in this chapter all the student examples carry a high load of predications.)

Problems in the Use of the Relational Form

The relational form is so called because a relational predication becomes the surface predicate, as in

This is because of _____

or

_____ is like _____

For the student writers, the form caused syntactic trouble, no doubt because it requires that content sentences be grammatically reduced. Notice that in a sentence like "An example is . . . ," the main verb is taken up with its relational function, so the verb of the content sentence must either become the verb of a subordinate clause or even change itself into a noun. Consider the difference between

This is because _____

and

This is because of _____

Consider what will happen when the student wants to combine one of these sentence openers with the following:

Sodium and potassium pass through the cell membrane.

Both of the "because" openers will take the content sentence, but only the first takes it without modification. The second requires insertion of "the fact that" or reduction of the sentence to a nominal.

Since the biology writing task was relational by nature, the students found themselves using such sentence openers quite frequently, and quite frequently the syntax of the opener demanded the grammatical manipulation of content sentences. This manipulation, in turn, offered opportunities for making numbers of errors. Sometimes the errors were strictly grammatical—the students failed to nominalize or to make verbs agree with surface subjects—and sometimes they involved simple precision or accuracy. The relational form makes rather difficult demands on its user in both respects.

Problems with precision. Writers wishing to express a complex analogy frequently say two things are alike when they are not alike, as in the sentence below:

These errors in development are like the child who uses "see'd" instead of "saw."

This statement is incorrect; that is, the errors are not like the child. Similarly, students produce sentences they would see, on closer examination, to be factually wrong. They say an entire situation is an example of something when only an element of the situation is the example. They say, "This is because . . . ," even when they are not quite sure what this is. These are problems of imprecision.

These problems, whether they stem from language or thought or both, are not unlike those of mathematics students who figure percentages. In doing the computation, students may forget that their answer is really a percentage, or they may forget what it is a percentage of. They know the principles of the operation but lose sight of them in the process of working with the numbers. To "know" is one thing, but the production of correct answers or meaningful prose may be quite another.

Carol and the relational form. In the case of Carol, the sentences below show the roughness of both language and thought that are the result of her very deliberate attempt to engage in the relating process. Every sentence below uses the relational form. The following, in which the relational form is underlined, is a typical problem sentence:

> Some examples of physical barriers would be that all the epithelium of the mucus layer of the digestive system has tight junctions, which allows nothing to enter intercellularly, only through the epithelial cell, and the outermost cells are cornified.

What she has done is to use the relational form as the basic framework of the sentence:

> Some examples of physical barriers would be _____

Then to fill in the blank that is left, she uses an entire sentence instead of the noun phrase ("tight junctions") that is required. As a result, the referent of "which" is rather hazy. Is it "tight junctions," in which case the verb "allows" does not agree, or is it the preceding clause?

Carol's sentence is perfectly clear. Its relationship to what has gone before is well understood. But the structure is clumsy to say the least. The "for example" phrase would have been easier to use because it allows the content sentence to remain in its original form:

> For example, all the epithelium of the mucus layer of the digestive system has tight junctions, which allow nothing to enter intercellularly.

Or, if the relational sentence form were important to the writer, then the subordinate sentence should have been modified:

> Some examples would be the tight junctions of the digestive system's epithelial layer . . . and the cornified outer cells.

In many of the sentences Carol has written, she has apparently spliced a relational predicate together with a content predication that she remembered. The rough splicing technique shows itself above and recurs in the following sentences:

> One of these characteristics are skeletal muscles are multinucleated.

> Another physical barrier is that among the epithelial cells there are cells which secrete mucus that traps the invaders with this sticky substance while the ciliated epithelial cells move the bacteria out to be swallowed and digested or secreted.

And in the following, the clumsiness is exaggerated. What should have read:

> The digestive system has immune system components. These are needed because the surface of the alimentary canal is the first thing an invading substance comes in contact with.

reads instead as:

> The digestive system has immune system components. This is because it is considered an external surface in the tube within a tube body plan and is the first thing an invading substance will come in contact with.

Several elements having nothing to do with the causal relation clutter the sentence above and obscure the meaning. These elements are vestigial phrases, left over from the sentence as it was probably learned from lecture notes. The phrase

> it is considered an external surface in the tube within a tube body plan

really belongs to another set of information. In this and other cases, Carol failed to peel away the irrelevant part of the phrase and highlight what was most relevant.

Admittedly, it takes a good bit of skill to use the relational form when one must integrate it with content information which is itself complex. For example, Carol's sentence about muscle cells contains quite complicated ideas:

> This is because they are long cells and because of this to keep the cytoplasm to nucleus ratio small many nuclei are needed per cell.

Using the form "This is because . . . ," the version below, with which I struggled, is only slightly better than Carol's:

> This is because, being long cells with a good deal of cytoplasm, they need many nuclei to keep the cytoplasm to nucleus ratio small.

Carol writes much more easily when she does not feel constrained to use the relational form, as shown by the following sentence:

> But in cardiac muscle cells there is only one nucleus because the cell is smaller and there is less cytoplasm to be controlled by the nucleus.

The structure of the main clause. Sometimes the problem with relational forms was with the structure of the surface predication, most commonly a problem for the foreign students, though also for Rudy. How does one assert that something is the purpose of something, that something happens only under certain conditions, or that two things are similar? As straightforward as such ideas seem to be, students were occasionally unfamiliar with the required idiom. Just as Rudy had trouble with the construction, "the more (something), the more (something)," students had trouble with the idiom used for purpose and contrast. The following examples are, in some small way, less than idiomatic:

> The digestive system is for the digestion of materials.
>
> The difference is due to the rate of contractions.
>
> (something) is somewhat directly proportional to (something).

Even Richard, the student with the best syntactic control in the class, had occasional trouble with relational forms, as is evidenced in the following sentence in which he failed to complete the comparison that is promised by the main clause:

> The difference between the two types of response is that the non-specific response reacts against any foreign molecule and prior exposure to the foreign molecule is not needed for the defense mechanism to work.

He must use another sentence to complete the comparison:

> The specific immune response on the other hand requires previous exposure to the foreign molecule and specific sites on the molecule must be recognized for this defense system to work.

When a noun, not a clause, is required. Relational forms could be better managed when the element that functioned as an example or a cause was a simple noun rather than a complex phrase or clause. The following sentence, written by Carol, is easy to read. In this case the simple noun needed for construction does not have to be ex-

tracted from the sentence in which Carol learned it. Apparently in her hierarchy of information it stands alone, not bound up in a clause structure as the "tight junctions" were bound up in an example cited early in this chapter.

> An example of this is pancreozymin, which is secreted by the small intestine and has as its targets the smooth muscle cells of the gall bladder, the acinar cells of the pancreas, and the cells of the stomach.

The relational form as starting point. For all the trouble caused by the relational form, it was clearly a device for helping the students think. It was a means of keeping control of what was otherwise an unmanageable amount of information. In Carol's case, the relational predication was one of two starting points. That is, she could start out her thinking with the relational form: "The reason for this is . . . ," "An example of this is . . . ," or "A difference is . . ." The other starting point was a vocabulary of superordinates, or general words such as "systems," "functions," and "barriers," each one a class with various members. The superordinate word was used as the sentence topic, the relational information as the main predication. Her sentence construction suggests that she wrote her relational predication and the superordinate word before she thought about the rest of the sentence. One sentence begins:

> Some examples of chemical barriers are . . .

"Examples" in the plural form and the verb "are" both anticipate more than a single example, but as it turns out, there is only one:

> Some examples of chemical barriers are the varying pH in different parts of the digestive system.

This sentence suggests that she wrote the opener before she finished her thinking, or in other words that her relational predicate and not the content predicate came first in her composing.

Relationships as topics. The sentence above reveals a real preoccupation on the part of the writer with relationships. Rudy would not have made the agreement error that Carol made in the example sentence above. His sentences were not **about** relationships but **about** the pH, or digestive layers, or muscle cells, or alveoli. He did not, at least in his early essays, have a problem in finding a new verb to go into a newly constructed relational form. He simply used the original predication that came attached to the pH, the digestive layers, the muscle cells, and so on.

Problems with Non-Relational Forms

It is, of course, possible and perhaps even preferable to express relationships of cause, comparison, illustration, and so forth in ways other than the relational sentence. The relationships can be implicit. They can be expressed by such short forms as the adverbs "also" and "consequently." They can be expressed by subordinate clauses of one kind or another. Syntactically speaking, these forms seem simpler to write.

But the students frequently chose the complex relational forms, and they chose to convey the ideas explicitly rather than implicitly. Carol's work, shown above, was the most extreme in this respect, but there were others as well. One student, Kari, almost invariably divided his material into three parts, each an example of the main idea. The first sentence of each paragraph usually began, "An example of this is . . ." or "Another example is . . ." Like Carol, he used relating language deliberately and explicitly, and also like Carol, he was one of the three who did well on the multiple-choice examinations given in the course. Whatever clumsiness the relational form may have produced in the prose of these students, it likely stemmed from a verbal habit that had enormous cognitive benefit for them.

Failure to use short forms. The relational words that the students could have used

but did not were the single words or short phrases such as "similarly," "particularly," "for example," "on the other hand," or "as a result." It is interesting that Rudy, when he tried to use them in a very early piece of writing, made glaring mistakes. In the following sentence, "as well" is clearly wrong:

> He finally narrowed it down to a proper concentration where curare would not cause death but would cause a sedative effect as well.

Similarly, the word "nevertheless" is used incorrectly below:

> Bernard after becoming an intern showed a great deal of interest and enthusiasm in Magendie's experimental method approach on body physiology by participating in numerous Magendie research projects . . . Nevertheless, Bernard's future was greatly reflected by his acquaintance with his teacher Francois Magendie.

In sum, Rudy was not completely in control of the language needed for conveying relational information in short form.

Richard was the only one in the group who made good use of short phrases like "on the other hand." He was quite good with words like "vary," which conveys contrast, and more than anyone else he made use of implicit relationships of contrast and generality. The other students, including Carol and Rudy, made little use of the short forms for conveying relational information. Carol almost always failed to make it clear whether the word "also" went with the subject or the verb of the sentence. That is, if one says, "The cardiac muscle also contracts rapidly," the context must make it clear whether one is comparing cardiac and skeletal muscles or listing a second attribute of cardiac muscle. Is the writer saying "also contracts (in addition to expanding)," or "This is also true of cardiac muscle (in addition to being true of skeletal muscle)?" In Carol's case, the word "also" was often puzzling because one could not tell which meaning she had in mind.

Failure to delete. Furthermore, in some cases several students failed to make use of very elementary linking devices such as pronouns. Rudy and Tomas, in particular, tended to repeat, long and laboriously, phrases that should have been deleted completely or replaced by pronouns. One example will suffice, produced by Rudy on the last essay of the semester:

> Several systems are involved in the maintenance of salt and water balance. One system involved in the maintenance of salt and water balance is the urinary system.

Failure to form relative clauses correctly. Some students, Rudy in particular, were not familiar with the various means for forming relative clauses. In fact, Rudy did not recognize the correct form when he had written it. The words he crossed out and inserted are as revealing in this case as in others. Having written the partial sentence,

> There are also digestive hormones originating . . .

he crossed off the -ing from "originating," added an -s, and inserted a "that":

> There are also digestive hormones that originates . . .

In other words, he created an error instead of correcting one, for his result is less grammatical than the original. Having written this much, he continued with the sentence, attempting to embed the sentence, "They can act upon more than one target cell." But instead of using a relative pronoun, "which" or "that," he used the inappropriate "and." The entire sentence now contains two errors:

> There are also digestive hormones that originates from the intestinal epithelium of the small intestine and can act upon more than one target cell.

On another occasion when the relativizing process was called for, he failed to make the verb forms parallel:

> Another hormone which has more than one target cell and thus regulating more than one activity . . .

The following examples, all of them collected from writing done in the semester before the actual study, show Rudy's considerable difficulty with the relativizing process:

> He vastly improved his moral character as an extern under which was spent evenly in the hospital wards and the dissection rooms.

> Bernard would collect this fluid from cadavers in which he invented a special technique for this purpose.

> The discovery of a starchlike substance which is formed in the liver and it became regarded as the sole energy reserve in the body was done by Bernard.

> He carefully studied curare toxicity and finally narrowed it down to a proper concentration where curare could not cause death but would cause a sedative effect . . .

Failure to use the characterizing reference. Another effective relating device not used by the students was the characterizing reference. Or, to be accurate, it was used just a few times in the entire collection of essays written by the students, and only by Tomas:

> The retention of excess salt and water in the extracellular spaces is like drowning the cells. Such a metabolic accident must be avoided.

The "metabolic accident" is a reference to "drowning the cells," yet it does more than refer—it makes an extra statement or predication. The sentence might read:

> Such a metabolic accident—and this is what it is—must be avoided.

The referring phrase adds the item of information that the drowning **is** a kind of accident. The pair of professional science writers, Tricker and Tricker, whose work was quoted in the last chapter, use the device to good effect both when they refer back to "some easily reversible bonding between actin and myosin" as "bridges" and when they refer to "the sliding of one set of rods into the other" as "this explanation." It is not obvious to the reader that the first process **creates** a kind of bridge and that the second **is** a kind of explanation; the information is helpful.

What is striking is the rarity of graceful sentences with high predication loads. Richard, as mentioned earlier, was the exception in the group. He could write sentences with such loads, sentences exhibiting both grace and economy. The sentence below, for example, contains a large number of relational predications. It shows that cells **are different** from each other, and that **the differences** have two sorts of **causes,** but that **on the other hand,** they have an important **similarity**. His sentence is simpler in structure that the one just written to describe it. It has only two independent clauses related by a comparison "but," a reduced relative clause ("depending"), and a complement structure ("in keeping"). The "in keeping" is less idiomatic than "to keep," but otherwise the sentence is clear and readable:

> The cells of the endothelial lining vary depending on their location and function in the digestive tract, but they all serve in keeping undesirable foreign particles out of the body.

By the end of the semester the Micronesian student, Tomas, was also writing many sentences that are complex in form yet clear and readable. The first "this" refers to his preceding sentence.

> This the body has to regulate so that its cellular activities, like the making of ATP and so forth, will not be hindered.

This sentence is complex in the sense that it contains a full adverbial clause ("so that SENTENCE") within which there is a nominalization ("the making of ATP").

In spite of what have been called "failures" here, it must be kept in mind that it was a mark of progress for the pre-medical students to combine relational information with content information. To do so is generally something of a turning point for the student of so-called "basic composition." The student's attempt to include comparisons, causes, results, and generalizations frequently spells the difference between meeting or not meeting the demands of academic assignments. The words "comparison," "cause," and "result" may be misleading, for actually the demand for this sort of thinking is a demand for imagination. Students are asked to juxtapose mentally several bits of data or fact and to come up with insights of their own. Admittedly the imagination is allowed short rein in the writing under study here. Nevertheless, every assignment that requires relational information asks students to bring together parts of their experience that have not been brought together before. Each assignment asks them to examine the relationship of these parts and to describe it.

When bits of experience are disparate—like the sensations of feeling rain and touching silk—then the search for a relationship is more commonly thought of as an imaginative exercise. But to some extent it is also an imaginative exercise to see the connection between absorption in one part of the body and absorption in another. To say that two body functions are similar in this respect is to reveal an insight of one's own. When students included relational information, this was evidence of such an imaginative exercise.

CHAPTER 7

Conclusions and Implications

Conclusions

Several interesting conclusions can be drawn from this study. For the sake of clarity, they are listed separately below even though they are interdependent.

(1) High predication load was a feature of the academic writing tasks that were part of this study. This feature may also help to characterize many of the assignments and essay examination questions given students at the college level.

(2) High predication load made the task of creating coherent prose more difficult than it would have been if the load had been lighter. The difficulty was felt, no doubt, by all of the subjects who used quantities of content, even though some of them handled the task more successfully than others.

(3) When the predication load of the assignment was high, two types of composing difficulties were revealed to be inherent in the task. Roughly stated, the difficulties were in "integrative thinking" and "phrasing for correctness and readability." These difficulties were quite distinct, and it was possible for a student to have one and not the other. Yet there was a relationship between the two, for the students who had done the integrative thinking were more likely to have problems with phrasing their sentences. In the case of students whose habits of integrative thinking changed from poor to good, there was actually an increase in the number of grammatical faults.

(4) The two types of difficulties call for quite different approaches in the teaching of composition, even when both problems occur—as they will—in the same classroom. Some student writers will not integrate content material with relationships; others will produce incomprehensible or clumsy prose because they have already integrated material. Whereas one student produces prose that seems too simple, another produces prose that contains errors of expression stemming from the complexity of idea. But we conclude now that the two kinds of problems are aspects of a single phenomenon. We could, in fact, conclude that the two writers, under some conditions, may be the same writer at different stages of development.

(5) Generally speaking, the study argues for a sophisticated view of the sentence. The sentence may have a double function, expressing both relational and content information. When each kind of information is seen to fit a syntactic pattern and when the cognitive demands of the task require more than a single kind, then the sentence is seen to be the result of the interplay of syntactic resources and cognitive demands.

Teachers sometimes speak of teaching the structure of the sentence or of students who have not learned how to write a sentence. But if "the sentence" is learned at Grade 1, it will have to be relearned at each step of the writers' growth. The writers' sense of the sentence will have to keep pace with their maturing sense of the types and strands of information required by various kinds of discourse. Teachers must expect new kinds of sentence problems to occur as developing writers take on writing tasks that

are increasingly varied and, in some academic contexts, extremely complex. (I will return to the analysis of tasks later in this chapter.)

(6) Finally, a caveat. The predication load required by the assignments or carried by the student writer is describable in the numerical terms offered by the construct of predication load. The usefulness of the numbers, however, must be carefully qualified. They are useful mainly for purposes of clear communication because they show in simple summary fashion the total of several pieces of information. They are a measure derived from information about individual sentences as well as a group of sentences and as such reflect both the sentence and the passage levels. They are not useful, however, for large-scale assessment. They are no more accurate for this purpose, and much more time-consuming, than the intuitive judgments made by sensitive readers. Moreover, the numbers above certain values cannot be depended on for measuring increasing quality. The numbers are useful merely for showing the presence or the absence of coherence, as it is operationally defined in the study. The construct itself is a qualitative rather than a quantitative measure; the numbers call attention to particular sentences or particular passages that may have gone wrong, help to explain the reasons for the problem, and suggest what the composing problem of the writer is.

Further Implications

Let us now raise two questions, one of generality, the other of applicability to teaching.

Information strands in writing outside of biology. Can information strands parallel to those found in the biology writing be identified in prose in other subject areas? No very general claim on this point can be made without a great deal more empirical study, but it will be useful to look at two examples.

The first is a student examination essay from an ethnobotany course. Though the course was taught by a botanist and the subject matter was similar in some respects to that of biology, the prefix "ethno" in the course title introduced two dimensions that we did not see in the biology writing. In addition to the structure and function of plants, the course was concerned (1) with people and (2) with the past. Specifically, the student taking this course was expected to learn how native Hawaiians made use of plants before the coming of American and European explorers.

The particular issue the student had to address was the following:

> When the first Polynesians arrived on the Hawaiian Islands, they had to sustain themselves on the materials they found there (native plants). Using what you know about native plants, describe a hypothetical life style developed by these first settlers.

A coherent student answer to this question is provided in the passage below:

Example Passage

"Hawaiian Plants and Life-Style"

> Initially the migrants would have relied heavily on the limu for a food source (e.g., limu kala, limu kohu, limu manauea). These were very similar to or even identical to seaweeds of the southern hemisphere. We can speculate that niu (**Cocos**) was native and that this provided its nutritious solid and liquid endosperm to the newcomers' diet. Native berries ('ohelo berries) and the hapu'u, a source of greens (fiddleheads) must have been a relief in a plant diet otherwise dominated by starch from the tree fern trunks (hapu'u and ama'u). Not only was their diet bland and somewhat harsh, but their clothing would have been also. Mamaki, found growing wild, would have made a rough grade of kapa cloth. The strong native fiber, 'olona, which made some of the best cordage in the Pacific

and helped these people to net fish, might have been used in some way for clothing also. Medicines would have come from the flowers of the plant 'olona, and also from the lehua and limu kala. As for housing, the native pili grass provided a good thatching material, but it was used in conjunction with less-than-ideal frame materials of 'ohia and mamane, plus the native 'ohe.

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When we analyze the sentence syntax of this essay, it becomes clear that the writer has managed to carry an appropriate relational load without (with one exception) using the relational form. (The relational form is found only in the second sentence, "These were very similar to . . .") His main verb positions, therefore, are left free for the expression of content information.

On investigation, we find four strands of content information, each with a particular sentence topic and verb features:

Strand 1:	the migrants (topic) would have done or been (conditional verb)
Strand 2:	food, clothing, shelter, or medicine (topic) would have done or been (conditional verb)
Strand 3:	plants (topic) were or did (past tense, not conditional)
Strand 4:	plants (topic) would have done or been (conditional verb)

Of these, Strand 4 is repeated most often by the student writer. The pattern of repetition shown in the series below makes the passage easy to follow:

this (niu) provided its . . . endosperm
native berries must have been a relief
mamaki would have made a . . . cloth
olana . . . helped these people to net fish
(olana) might have been used in some way for clothing
the native pili grass provided . . . thatching material

Where the parallelism of structure breaks down slightly the reader has no problem following. The omitted conditional element in two of the examples above is easily supplied by the reader, who sees the writer's intent. Where the information strand does not conform with the pattern above, as in the opening, "The migrants would have relied . . . ," the intruding clause structure is Strand 1 or Strand 2 information. "The migrants would have relied . . ." is Strand 1. "Plant diet (was) dominated by starch" is Strand 2. "Niu was native" is Strand 3.

The importance of this variety of strands is in the way they parallel the question itself. Three different topics in the question are represented in three information strands: (1) the migrants . . . ; (2) food, clothing, shelter, and medicine . . . ; and (3) plants. The word "hypothetical" in the question is represented in the conditional element of these strands, the "must have" or "would have." Notice the phrase, "We can speculate that . . . ," which is another way of expressing the conditional.

Though the writer depended mainly on Strand 4 for composing processes, he also was mentally holding the other strands called for by the question. The difference between Strand 3 ("plants were or did . . .") and Strand 4 ("plants would have been or would have done . . .") demonstrates a kind of mental balancing act. Where the verb is the regular past tense—not conditional and not intended to be—the writer is speaking of what he knows to be true about plants in the past; the movement between the regular past tense and the conditional past is a linguistic marking of the movement from fact to inference. The writer has done what the question asked him to do: move from his factual knowledge of plants to his inferential knowledge about the migrants' use of these plants.

What we can infer from this single piece of writing is that the student in this situation, no less than the student of biology, was constrained by the assignment to use particular information strands with given syntactic features. We see that in the hands of this student writer a heavy relational load was handled without the use of the relational form, and that a single information strand used repeatedly was a means of maintaining coherence. We can also see, however, that a good deal of deviation from the main information type could be tolerated. We can speculate that under certain conditions a great many extraneous or non-conforming information strands may be introduced without breaking the flow.

But what are these conditions? If we look at a piece of writing that straddles the border between academic and non-academic prose, we see a curious sort of shifting. Where the relational load is light, the reliance on parallels between predications of the same information strand is heavy. And vice versa. Where the prose is full of cause/effect and comparative elements, there are many fewer parallels of information strand and a large number of different strands.

We find this shifting from structural to logical coherence in Konrad Lorenz's book, **On Aggression,** which I have chosen as an example of writing that is both academic and written in layman's prose.

Example Passage

"Prologue in the Sea"

My childhood dream of flying is realized: I am floating weightlessly in an invisible medium, gliding without effort over sunlit fields. I do not move in the way that Man, in philistine assurance of his own superiority, usually moves, with belly forward and head upward, but in the age-old manner of vertebrates with back upward and head forward. If I want to look ahead the discomfort of bending my neck reminds me painfully that I am really an inhabitant of another world. But I seldom want to do this, for my eyes are directed downwards at the things beneath me, as becomes an earthly scientist.

Peacefully, indolently, fanning with my fins, I glide over fairytale scenery. The setting is the coast of one of the many little islands of coral chalk, the so-called Keys, that stretch in a long chain from the south end of the Florida peninsula. The landscape is less heroic than that of a real coral reef with its wildly cleft living mountains and valleys, but just as vivid. All over the ground, which consists of ancient coral rubble, can be seen strange hemispheres of brain coral, wavy bushes of corgonia and, more rarely, richly branched stems of staghorn coral, while between them are variegated patches of brown, red and gold seaweed, not to be found in the real coral reefs farther out in the ocean. At intervals are loggerhead sponges, man-broad and table-high, almost appearing man-made in their ugly but symmetrical forms. No bare surfaces of lifeless stone are visible, for any space between all these organisms is filled with a thick growth of moss animals, hydroid polyps and sponges whose violet and orange-red species cover large areas; of some organisms among this teeming assortment I do not even know whether they belong to the plant or the animal kingdom.

My effortless progress brings me gradually into shallower water where corals become fewer, but plants more numerous. Huge forests of decorative algae, shaped exactly like African acacia trees, spread themselves beneath me and create the illusion that I am floating not just man-high above Atlantic coral ground, but a hundred times higher above an Ethiopian steppe. Wide fields of turtle grass and smaller ones of eelgrass glide away beneath me, and now that there is little more than three feet of water beneath me, a glance ahead reveals a

long, dark, irregular wall stretching as far as I can see to each side and completely filling the space between the illuminated sea-bed and the mirror of the surface: it is the border between sea and land, the coast of Lignum Vitae Key.

The number of fish increases rapidly, dozens shoot from under me, reminding me of photographs of Africa where herds of wild animals flee in all directions from the shadow of an aeroplane. In some places, above the fields of thick turtle grass, comical fat puffers remind me of partridges taking off from a cornfield zooming up only to glide down to land again in the next field or so. Other fish, many of which have incredible but always harmonious colours, do the opposite, diving straight into the grass as I approach. A fat porcupine with lovely devil's horns over ultramarine blue eyes lies quite quietly and grins at me. I have not hurt him, but he—or one of his kind—has hurt me! A few days ago I thoughtlessly touched one of this species, the spiny boxfish, and the razor-sharp parrot-beak, formed by two opposing teeth, pinched me and removed a considerable piece of skin from my right forefinger. I dive down to the specimen just sighted and, using the labour-saving technique of a duck in shallow water, leaving my backside above the surface, I seize him carefully and lift him up. After several fruitless attempts to bite, he starts to take the situation seriously and blows himself up; my hand clearly feels the 'cylinder strokes' of the little pump formed by the pharyngeal muscles of the fish as he sucks in water. When the elasticity of his outer skin has reached its limit and he is lying like a distended prickly ball in my hand, I let him go and am amused at the urgency with which he squirts out the pumped-in water and disappears into the sea-weed.

In the first four paragraphs Lorenz involves his reader in a visual exploration of the underwater coral reef off one of the Florida keys. This passage depends on structural elements for its coherence. There are four content strands, as follows:

Strand 1:	I (topic) do or am, am doing, or am being (historical present, occasional progressive)
Strand 2:	inanimate pieces of the landscape (topic) are (statal, present)
Strand 3:	fish (topic) do (historical present, generally dynamic)
Strand 4:	a fish (topic) did (past tense)

It is interesting to watch Lorenz capture and hold his reader's interest. The topic of differentiation through natural selection is one that will be central to the book's theme, yet Lorenz develops this academic topic as if writing a novel. Paragraph 1 involves the reader with the experience of the writer: all Strand 1, "I am doing," information. Paragraph 2, while it uses Strand 1 predications at the opening and closing, is otherwise completely taken up with the naming and description of pieces of the landscape: all clause structures are Strand 2, "the landscape is . . ." Paragraph 3 continues to use these two strands exclusively. Paragraph 4 uses these two at the same time as it introduces two new strands, both of them having "fish" as the topic but differing in the number of fish and the tense of the verb. For Strand 3 the topic is "fish" in the plural, and the verb is the historical present; for Strand 4 the topic is a particular fish, and the verb shifts to past. In these four paragraphs the shifts from one topic to another and from one verb feature to another are astonishingly few, the same ones being repeated a great many times.

To find so few strands in the first few pages of prose is a distinct contrast with what one finds in the next chapter. For instance, in one paragraph composed of 10 sentences, there are 19 relational predictions but a large number of strands and very little repetition of a single strand. The sentence below, for example, is heavy with causal information, and the sentence topics (thus the information strands) shift wildly. The reader, who had earlier been easily led by the parallels of structure, now finds the go-

ing tougher:

> and when, owing to a small, in itself, fortuitous, hereditary change, an organ becomes a little better and more efficient, the bearer of this character, and his descendants, will set a standard with which other, less talented members of his species cannot compete . . .

Further investigation of various prose types will tell us when and where writers make use of the structural parallels offered by the repeated use of an information strand. Perhaps further investigation will also clarify the various syntactic features that mark these types. I have noticed them particularly in terms of verb qualities, but other areas of syntax may be similarly involved.

Developmental writing in the academic context. The second question we will address here concerns the applicability of the study to teaching, especially the role of writing in teaching the content areas such as science, history, or literature.

In the content areas, students write for the purpose of learning more about some aspect of the subject matter, of putting into practice some principle studied in the course, of simply reflecting on what has been learned, or of in some way processing the information content of the course. Writing assignments are usually intended to serve the wide-ranging instructional goals of the course: to help students understand the political process, the relation between history and culture, or the systems of inquiry in the sciences. Writing assignments are ordinarily a chance for students to relate specific data to these more abstract concerns, which in turn relate to the students' own lives and experience. The object of the writing is to encourage the students to come to what is probably an old and familiar issue through the medium of some specific and concrete problem. The purpose is for the students to see the issue or idea in their own terms and in their own language. Such was the purpose even for the premedical writing, the idea in this case being the amazing relationship between form and function in the human body.

Instructors setting writing assignments have the responsibility of deciding how much the student should be concerned with relationships, or in other words the extent to which they should introduce the notions of cause, comparison, specification, and generalization. When the demand for relationships, thus the predication load, is rather light, the writer is quite possibly freer or more inclined to use a pattern of coherence like the one used by Konrad Lorenz in his early paragraphs. The students would introduce one strand of information at a time and only mix them as they proceeded further into the paper.

Suppose that for a history class the following list represents information strands believed by the course instructor to be relevant (and for which the verbal features are given, though the topics are missing and would have to be supplied for the given course):

(1) What happened? (dynamic verb, past tense)
(2) What had happened before this? (dynamic verb, past tense, perfect aspect)
(3) What were conditions then? (statal verb, past tense)
(4) What were other groups doing at the time of this event? (dynamic verb, past tense, progressive aspect)
(5) What has happened since then? (perfect aspect, present tense)
(6) What happens nowadays or ordinarily? (dynamic verb, timeless present)
(7) What happens under various conditions? (present tense, conditional mode)
(8) What is/was true about this? (relational information—statal verb, present or past tense)

The instructor setting the writing assignment for this course would decide which and how many of the above questions the students should deal with, and how early in the

paper the various kinds of information should be integrated. In this way, the instructor could control the predication load the student had to work with or carry. The way in which the load is manipulated would depend on the instructional goal of the instructor. He might want the student to presuppose familiarity by the reader with the content information—in which case the student is assumed to be familiar with it too—and to make use of the writing exercise to write about the relationships between parts of the material. In this case the instructor could write the assignment so as to impose a heavy predicational load on the entire piece of writing. On the other hand, he might want the student to research new material and then to relate it to the principles of the course. In this case, the assignment would be written so as to show that the paper would have two or more parts, and only in the last of these parts would the student's relational information play a significant role. The early parts might have quite a low predication load and would serve a "telling" function; the later part would serve a "discussion" function.

Relational assignments, heavy predication load. The examples in this section all fit the need for assignments with heavy predication load, or a heavy emphasis on relationships.

1. *People have said that modern literature, TV, and drama are all sex and violence. Others say this is a natural reflection of the temper of the times. How do you explain the existence of obsessions of one kind or another in the work we have been reading? Why do you think writers write this way?*

The questions asked in this assignment presuppose reader familiarity with the text, but clearly the instructor wants the students to refer to events and people in the text. The main thrust of the questions are relational: **name reasons or causes, tell why.** Also required here is information about people or events in contemporary times. In both the text and the real world, the information may be about things that happen or conditions that exist—adding two more information types to the predication load. As a result, this assignment can be very complex. Developing writers will predictably answer the relational thrust of the questions but not integrate it with **content** predications, either about the world or the text. **Or,** in the attempt to integrate, they may provide a "for example" but fail to pull from the example incident the relevant part—in which case readers are left to find it for themselves or miss the link altogether. It is to be expected that only occasionally will developing writers construct sentences that pull together content and relational predications (even implicit relational predications). When they do pull together such predications, the sentences will predictably be clumsy.

2. *What does recent research in physics suggest about the atomic theory?*

The answer to this question is a relationship—some recent research **shows** something—so in this case as well the main thrust of the assignment is relational. Other information types will be: What was the atomic theory? What is the modified theory? What did the researchers do? What were the results?

To integrate all of this information in single sentences will be next to impossible. Writers, even very accomplished ones, will be forced to separate types of information to some extent. Though they can begin with an integrated statement about what the recent research suggests, they will have to use some sentences just to say what findings the existing theory depends on, and what the recent findings were, before they can say how the recent research challenges the conventional theory and what it suggests in the way of a modified theory. For developing writers, it will be even harder to convey a sense of integration throughout the paper. Even if they are well organized and coherent, their essay may result in a three-part story of which only the third part seems connected with what goes before. In other words, of the following three parts,

the writers will have trouble making links between the second and the first: (1) what the conventional theory is, (2) what the researcher did, and (3) the relationships between the findings and the theory.

Other assignments that require high predication loads are those frequently given on essay examinations:

3. *Compare the English and French Revolutions in terms of their causes and effects.*
4. *Compare the three kinds of religions studied in this course with regard to doctrine.*

Given the usual time allotment of 20 to 30 minutes to answer such questions, students who can manage any sort of integration are unusual. Developing writers will predictably give either a general answer of the relational kind, if they happen to remember similarities and differences from their notes, or they may avoid the relational altogether and write only information on the content level. There is usually not enough time for the students to review mentally the content material and arrive at their own relational insights. Thus the opportunity for the imaginative exercise of relating is ordinarily lost, even for those who ultimately come up with comparative statements. Giving questions of this kind requires the students to review too much content material in a short period of time. The result is that they will simply not do it; they will use relational statements they remember or have previously thought out, or not use them at all.

With all assignments in which the main thrust of the assignment is relational, instructors can expect sentence construction that is less than graceful, to say the least. Clumsiness can be expected, especially when the writer uses the form called here the "relational form":

This is because of **(embedded sentence)**

or

(embedded sentence) explains the **(embedded sentence)**

One can expect clumsiness and grammatical errors in the words that fill the blanks, assuming that the student has tried to fill the blanks with content statements. Even the student who can express relationships without the use of the relational form runs the risk of misusing the short forms, or words like "also" or "only," often misplacing them in the sentence (one of the traditional "misplaced modifiers"). Usually the most graceful way to show relationships is to make them implicit, but, judging by the writing in this study, many students seem to lose control of their message when they do not use explicitly relating words or forms. Without the explicit marks of relationship, the material has a way of going off on its own. That is, the students find themselves imitating whole structures of information that they have heard or read instead of pulling information out of these structures to use for their present writing purposes.

Non-Relational Assignments, Low Predication Load

There are, of course, instructional purposes best accomplished by writing assignments whose main thrust is **not** relational. For such an assignment the student's task would **not** be to show the relationships between bits of content with which the reader was presumed to be familiar. Rather the task would be to **tell**: to tell what happened, for instance, or to "introduce" something by way of the introductory form described in Chapter 3. The effect is a lower predication load, for the student is allowed to deal with a single strand of information, or perhaps only two strands. Such a strategy allows for the separation of material rather than integration.

If, say, the instructor wanted the student to create a descriptive portrait of some sort, and the depth and intensity of this picture is the important goal—important for the student both to create it and to feel it—then a lower predication load can be imposed. Suppose, for example, the teaching purpose is point of view and the object is to have students select and reject information to fit the point of view. Then the following assignment is well-suited to this purpose:

1. Write a short biography of Henry VIII as though you considered him, in an affectionate sort of way, the father of English traditions or culture.

   Write another portrait of him, this time showing him to be a cruel tyrant.

The parallel relational assignment, one requiring a higher predication load, is this one:

> For what reasons might the British today still feel affection for King Henry VIII, and for what reasons might they abhor his memory?

Another parallel set of assignments is this set:

2. [non-relational] Write a sermon as though you were Jonathan Edwards living in the 1920's.

   [relational] Contrast the eighteenth-century Calvinist values of Johathan Edwards with the values of the 1920's (as revealed by the writers read for this class).

Another set is this one:

3. [non-relational] Tell what Huckleberry Finn did in some instance as though you were the Widow Douglas and knew what he had done.

   [relational] Contrast the values of Huckleberry Finn with those of the small-town Missouri society in which he lived.

The non-relational assignments above have a dramatic and imaginative purpose, but other non-relational assignments can be straightforward attempts to make possible relational thinking without relational writing. The following, for example, leads students into thinking about conflict in a literary work:

4. [non-relational] In every book there is a fight, a hostility, or just a tension of some sort. In the book you read, what (or who) was this "fight" between? What led up to it? Narrate, like a movie, the 60-second period of time that you think was the high point. Then tell what happened afterward, or how the whole thing was resolved or not resolved.

In this case, it is expected that the students will have understood the logical connections between early and late events and so will be able to select with sensitivity the events that were related to each other, but will be unable to say in any explicit way what the relationship was. They will be able to focus on the imaginative re-creation of the climactic scene and be able to retell it with good powers of memory. The assignment thus manages to engage their feelings in the notion of conflict and to put to use their powers of selection and retelling.

To allow for separation in this way, even to allow for the avoidance of relational statements in some cases, is justified in terms of the instructional purpose. It allows for the sequencing of assignments from easy to difficult; it allows for greater emphasis on the visual, the narrative, the immediacy of the event, and the sense of "being there." In the science class, the set form of the lab report makes it easy to put down information that is in itself difficult or complex. The form separates one kind of informa-

tion from another: (1) the general question or theory under study, (2) methods and procedures, (3) results, and (4) discussion. Only in the "discussion" section must the student integrate perhaps several information types. The other sections require only low predication loads.

Relational writing in the large-group class. There are times when the instructional purpose suggests that the form of the writing must be integrative throughout. Trying to relate information is an important intellectual exercise. Thus, giving assignments of the relational kind is important even when the class is very large and a sizeable minority have troubles with writing.

The professor of the subject-matter course who is willing to act on this belief should be forewarned. For developing writers, the tendency is first of all to avoid the high predication load. And even when they manage to carry it, their writing may be phrased in clumsy or incorrect English. But the unpleasant experience of taking in and grading such pieces of writing ought to be worth it in the long run. The piece that is not a sensible communication should identify the student who has not yet made sense of the information. Writing may be the only practice in trying to make sense of information that the student has.

The case studies of Rudy and Carol suggest that what the instructor does with the writing should depend on the developmental level of the student. There are ways to treat different students on different developmental levels and yet be fair to all. There may be only a few in the group who are "ready" for the close textual criticism and suggested rephrasings that most professors feel obliged to write in the margins of student papers. Others may fall into two large groups—those who have too little material and those who have too little message. In either of these two cases, the predication load is too low. Those with too little material have either left too much empty space on the paper—in which case the students themselves easily see the problem—or they have included only relational information and too little information of other types. In such a case, "You need more material" is sufficient response from the instructor. Those with the problem that Rudy had include material in quantity but without relevance. They should be told that the reader "cannot see the relevance of the material to the question or first sentence." If time permits, the instructor or teaching assistant can underline the sentences that seem relevant. The important goal is for the students to begin to evaluate their writing for relevance.

In a sense, this kind of instruction is like moral or ethical teaching. The students understand what honesty is; they just have trouble acting on the concept. But being reminded of it frequently, and having repeated tries at it, together with response from the observer ("Yes, you've got it . . . No, not this time"), leads to learning. For the writing exercise to be an effective teaching technique, the students have to be reminded of the concept, to be told whether they have managed it, and to be allowed several tries in quick succession.

Even in the very large lecture class, e.g., the required course in Western Civilization or General Science, students can be required to do a weekly piece of writing, short but very specific, requiring the students to pass judgment on some area of content or to relate various pieces of the content that had not been so related in class lecture. To spend 15 minutes of the discussion period in this way, or to require a single page of writing exercise to be an effective teaching technique, the students have to be reminded of the concept, to be told whether they have managed it, and to be allowed several tries in quick succession.

Why aren't such tasks given more often? First of all, the assumption is that they take too much time to grade and return. In fact, grading should not take more than two minutes per paper, and perhaps even less if they are simple read and marked as suggested below. For those students who clearly deserve detailed margin comments, such comments could either be provided or not, depending on the time of the profes-

sor and teaching assistant. Some universities have cooperating Writing Clinics that might be called in to do this kind of correction and editing.

Second, instructors feel that students who cannot write sensibly—that is, who show little control over the information—should not be judged in a subject matter course on their writing skill. Indeed, these writing exercises should not be weighted (1) as heavily as other kinds of tests and (2) so heavily as to put developing writers in jeopardy even if they fail on the writing exercise. At the same time, they should be weighted heavily enough to show the students the importance of being able to write about the subject matter.

What such a writing project would require in terms of course planning is two or three training sessions with teaching assistants (assuming a large lecture course) in which they would be taught to recognize papers with low versus high predication loads and to separate the paper with poor phrasing but good predication load from the paper that seems to be correct but in fact has low predication load. Teaching assistants are understandably distracted from the student's message by the poor use of language, or they do not notice that though the language is smooth, the content is irrelevant to the question. With practice, however, they should be able to separate papers quickly into four piles: (1) those quite good on all counts; (2) those with high predication load but problems with phrasing, style, and grammar; (3) those with low predication load because the material is somehow off the point or not clearly related to the point; and (4) those with low predication load because the content level is low. Grades within these categories should be given, depending on the degree of the problem, but the categorization process on its own would make both student and instructor aware of the student's position on the learning scale. It would give the teaching team a practical way of evaluating progress, for the categories 4, 3, 2, 1 are arranged in order of what may be a general pattern of student development.

Those with no content (Category 4) are clearly worse off than those with grammatical mistakes (Category 2), as are those with correctly written content but little show of writing that is relevant to the question (Category 3). (Of course, students in Categories 3 and 4 may also make grammatical mistakes, but this does not change their category. The prediction is that these writers will make even more mistakes when they begin to integrate material.) For a very quick measure of the progress of the class as a whole, the instructor keeps track of the numbers within each category and overall movement on the scale. This measure tells him how well the class is learning the difficult skill of using language for integration.

In addition to categorizing, the teaching team would need to work out a very quick way of handling the papers—collecting, returning, and recording—so that paper shuffling in itself would not be a burden. It can be annoying and self-defeating to use office space for a clutter of papers and class time for the passing of paper. Needless to say, for such frequent exercises the teaching staff should not be bothered with make-ups and student excuses for absences. The writing should be viewed, like class discussion, not as a test but as an important kind of verbal activity that both improves the students' abilities to handle the language and provides them with a chance to integrate and "think about" the course material. It is unlikely that the exercise would be taken too lightly, for any writing is viewed by most students as a rather frightening experience. They may, if given writing for homework, simply not do it at home. The advantage of in-class writing is that everyone produces; the disadvantage is the tendency to write before thinking. To discourage panic writing, students should be given a set amount of time to think or jot down notes before being allowed to begin writing.

At first, the struggle to become familiar with new material may make it difficult, if not impossible, to relate the material to what is already known. The lack of relational ideas, in turn, may make the writing produced by the developing writer seem incoherent. In the terms of this study, there will be too few relational predications. But the

assumption behind the suggested weekly writing is that the exercise of writing encourages the students to produce the relational notions; if they do not at first produce them, they will begin to do so under the pressures of the continuing assignments. A greater number of relational predications will make the writing, by definition, more coherent.

Implications for Research

Several of the claims made in this chapter and the last one should remain open to investigation. One is that information types parallel to those found in the students' biology writing will be found in student writing done for other disciplines. Another is that writing containing high predications loads can be distinguished by good readers from writing that (though coherent) contains a low load of predications. Both claims are easily investigated, the first by paper and pencil analysis of student writing in, say, history, and the second by a matching of the judgments of readers with the actual analyses of predication load. Both claims would need to be investigated before one attempted a large-class project such as the one just described.

The claim that assignments differ in the predication load they impose should also be investigated. Such a project would require that different groups of students matched for writing skill do different assignments, and that the writing be evaluated for readability and correctness. The prediction is that assignments imposing lower predication loads, allowing for separation of information types and less relational information, would lead to writing that was more readable and more correct—and possibly less thought-provoking—than writing done for other kinds of academic assignments. It would also be interesting to see a wide-ranging survey of academic assignments, together with samples of prose written by the instructors for the purpose of showing what they expected students to write in response to the assignment. Both projects would explore questions about academic writing: what kind of thinking are they intended to encourage, and do they do the job intended?

Another area of investigation is the whole developmental hypothesis suggested in Chapters 3, 5, and 6, as well as in the present chapter. Like many educators in the field, I urge that long-term developmental studies be undertaken, especially of students who enter college unprepared to handle the complexities of both reading and writing about academic subject matter. In the basic composition course such students seem woefully unprepared, but do they in the course of the next year or two pick up the verbal repertoire that seems to be required for processing the quantities of complex information they are expected to process? One can infer that Rudy, who still struggled with the basic vocabulary of relationships, had made large gains over the previous three years, while Tomas had made even greater gains. One would like to know how great the gains were, and how far late-beginning students can travel if they are motivated. The use of the methodology worked out by this study may be of some help in evaluating the writing done for long-term studies of this kind, for it can help explain the varying cognitive load in various pieces of writing.

Another way to investigate the developmental implications of the study is to carry out the project described earlier in this chapter, monitor it carefully in terms of the students' progress in coherence and correctness, and relate this information to scores on objective tests of the subject-matter content. Monitoring would mean spot-checking the judgments made by the teaching assistants each week—to analyze selected passages for predication load and match these against the judgments of predication load made by the teaching assistants—and keeping records of each student's score each week, that is, a 1, 2, 3, or 4 as explained earlier. The prediction is that there would be some movement upward over the weeks of the semester toward more relevant and more detailed writing. Just what kind of movement would occur, how much and by how many and for what reasons would be interesting questions to find answers

to. Such a project (the record-keeping would be aided by computer analysis) would be expected to show movement over time out of Category 4 (inadequate material) into higher categories—either Category 3 (material but without relevance to the main "message"), Category 2 (both material and message but problems with grammatical mistakes), or Category 1 (no problems with material, message, or grammar). If the findings of the present limited study are borne out, the writing of those who start in Category 3 will move upward to Category 2 before reaching (if they do reach) Category 1.

Important questions regarding the generality of the developmental sequence remain unanswered. What proportion of developing writers follow such a sequence, experiencing difficulties with grammar and sentence construction as they attempt greater integration? How many do not follow such a sequence? For example, how many take on the heavy predication load without attempts to avoid it? How many do so without showing difficulties with the grammatical construction of sentences? Such questions require investigation.

Finally, continued basic research in linguistics is necessary in order to discover more about the ways provided by the language for maintaining coherence. How writers make one sentence relate to what has gone before remains something of a mysterious process that contains both syntactic and semantic elements. How students acquire the means for creating coherence in the special language called writing is still an enormously complex question.

APPENDIX A

Passage on Types of Muscles*

Seen under the microscope, muscle is divisible into two main categories, striated and unstriated. A third and more specialised type is cardiac muscle, found in vertebrate hearts, which is immune from fatigue. Unstriated muscle, otherwise known as smooth muscle, is composed of discrete cells, each of which contains a nucleus in the normal manner. Smooth muscle is relatively slow to act and is found in the gut and bladder of vertebrates. In the gut it normally has an innate rhythm whose rate overall, rather than each individual contraction, is controlled by the nervous system. Such a rhythm is shown in Plate V (i) which was drawn on a revolving drum by a lever attached to an isolated piece of the gut of a worm. This preparation had no nervous input. Smooth muscle can exert a very large force for long periods in the closure of some mollusc shells, like the mussel. It seems that these muscles must be able to lock themselves in the contracted state, for they require little more energy then than when they are resting.

*from **The Science of Movement** by R.A.R. and B.J.K. Tricker (London: Mills and Boon, 1966), p. 68.

APPENDIX B

Rudy, Essay 1 (portion)

Muscle cells are cells specialized for contraction. Muscle cells can also be called muscle fibers. These fibers run longitudinally and parallel among each other. These muscle fibers constitute muscle bundles. The later also run longitudinally and parallel among each other to form the muscles of the body.

There are three different types of muscles in the human body. These three types are cardiac, smooth, and skeletal muscles. These muscles are different among each other due to location and physical appearances.

Smooth muscle can be found in the lining of the digestive system, respiratory system, and also in the excretory system. Smooth muscle fibers are under involuntary control of the autonomic nervous system. Smooth muscle fibers have longitudinal striations, but no cross striations. The width of smooth muscle fibers are very narrow, much narrower than the other two types of muscle. It has also a centrally located nucleus.

Cardiac muscle can be found in the lining of the heart. Cardiac muscle is also under involuntary control of the autonomic nervous system. These muscle fibers have longitudinal striations and cross striations. They also have a centrally located nucleus, sometimes there can be two nuclei instead of one. The width of the muscle is a little wider than of smooth muscle.

Skeletal muscle makes up the bulk of the body muscle framework. These muscle fibers are connected to tendons which in turn is connected to the skeletal system. These muscle fibers are under voluntary control (etc.)

Rudy, Essay 2 (portion)

Muscle cells transform chemical bond energy into mechanical work. The chemical bond energy comes from the breaking of the high energy phosphate bonds of ATP or adenosine tryphosphate during muscle cell contraction.

There are several ways of generating ATP or producing ATP for muscle contraction. Normally the production of ATP is found to occur within the cytoplasm of a cell and also within the mitochondria of the cell. If ATP is produced within the sarcoplasm of a muscle cell, it is normally ATP production from glycolysis. If ATP is produced within the muscle cell mitochondrion, it is called oxidative phosphorylation. Besides glycolysis and oxidative phosphorylation, ATP can also be produced from phosphagen pools, such as creatine phosphate and orginine phosphate. These phosphagen pools are also found within the muscle cell sarcoplasm.

In order to produce ATPs from glycolysis and oxidative phosphorylation, the presence of glucose molecules are needed within the muscle cell sarcoplasm. Glucose molecules are carried in the blood and are stored in these muscle cells in the form of glucose polymers called glycogen. Within the sarcoplasm of the muscle cell are certain enzymes which breaks down glycogen into individual glucose molecules. These molecules then goes through glycolysis and later on, they will go through oxidative phosphorylation.

A single glucose molecule that goes through glycolysis will produce two ATP molecules. Glucose is transformed into pyruvate at the end of the glycolytic pathway. Pyruvate can then diffuse into the muscle (etc.)

Rudy, Essay 3 (portion)

Certain characteristics contribute to important functional differences between cardiac and skeletal muscle are primarily related to the movement of certain intracellular and extracellular inorganic ions. The primary functional difference between skeletal muscle and cardiac muscle is due to the rate of contractions. The rate of contraction of skeletal muscle is much slower than the rate of contraction in cardiac muscle. The rate of contraction in muscle cells are directly influenced by the permeability of the muscle cell membrane to certain ions. The change of the muscle cell membrane permeability, as a result of nerve stimulation, can cause an action potential to be generated throughout the cell membrane. The magnitude of the action potential is somewhat directly proportional to the rate of contraction. The principal inorganic ions which plays an important role in muscle contraction are calcium, sodium, and potassium. Potassium is the principal intracellular ion, sodium is the principal extracellular ion and calcium is an important ion that promotes muscle contraction.

In order for muscle contraction to occur, there must be an action potential or transmembrane potential generated throughout the membrane. The inflow and outflow of these principal intra- and extracellular ions largely determine the magnitude of the action potential. Both cardiac and skeletal muscle action potentials have similar aspects. After nerve stimulation, acetylcholine from the nerve fiber, tend to diffuse across the myoneural junction and combine with the muscle fiber membrane. This combination or attachment of acetylcholine with the muscle fiber membrane will cause a structural change or a change in the permeability (etc.)

Rudy, Essay 4 (portion)

Smooth muscle action affects cardiac output. Smooth muscle is primarily found in the lining of the heart and blood vessels. The smooth muscle which affects cardiac output the greatest is found in the lining of the heart.* Smooth muscle which is found in the lining of blood vessels also effects cardiac output but to a lesser extent than cardiac smooth muscle.

Cardiac output is the amount of blood that leaves the left ventricle of the heart in a certain amount of time. The cardiac output of humans is normally about five liters per minute. Besides the effect of smooth muscle upon cardiac output, there are other factors which can also vary the rate of cardiac output. The cardiac cycle consist of four phases. The action of smooth muscle or the physical activity of smooth muscle effects all four phases. However, the phase of the cardiac cycle, in which the action of smooth muscle effects the most, is during the early portion of the systolic phase. That early portion of the systolic phase is known as the isovolumic contraction period. During this period, the ventricles of the heart are filled with a certain amount of blood. Inorder to pump the blood out of the ventricles, contraction must occur within the ventricular walls. The contraction of the smooth muscle within the walls of the heart ventricles is a certain type of muscle contraction. This type of contraction is called isometric con-

traction. Isometric contraction is the contraction of muscles at a fixed or constant length. The contraction of the smooth muscle (etc.)

*Rudy has confused cardiac and smooth muscle, a mistake which may have thrown off this entire essay.

Rudy, Essay 5 (portion)

The digestive system has immune system components. These immune system components are found in the walls of the alimentary canal. The walls of the digestive system consist of four distinct layers. The four layers are mucosa, submucosa, muscularis externa, and adventitia or serosa. Primarily, the immune system components are found only in the mucosa, and submucosa layers.

The mucosa layer of the digestive tract is comprised of three layers. The mucosa layer is the innermost layer of the four distinct layers. It is the layer that is closest to the lumen of the digestive tract. The three layers which constitute the mucosa layer are, epithelial cell layer (innermost), lamina propria (middle), and muscularis muscosae (outermost, adjacent to the submucosa). The lamina propria contains the major immune system components of the mucosa. In the lamina propria, there are lymph nodes, accumulation of white blood cells, and also loose connective tissue. The lymph nodes in the lamina propria produces the major specific immunological cells such as T-lymphocytes, B-lymphocytes, and plasma cells. These cells participate for the specific immune defenses of the body. The principal white blood cells found in the lamina propria are monocytes, eosinophils, and basophils. These cells participate for the nonspecific immune defenses of the body.

The submucosa is the next layer adjacent to the mucosa layer. This layer consists of dense connective tissue and also accumulation of lymphoid tissue. These lymphoid tissue are responsible for processing specific immunological cells. These specific immunological cells (etc.)

Rudy, Essay 6 (portion)

Increased surface area is important for the function of both the respiratory tract and digestive tract. The exchange of carbon dioxide and oxygen will take place efficiently over a large surface area of the respiratory system. The exchange of nutrients, vitamins, and water will also take place efficiently over a large surface area of the digestive system.

Primitive unicellular organisms did not have a respiratory tract and digestive tract. However, their exchange of gases, liquids and nutrients took place over a large surface area in an aqueous medium. The necessary gases, nutrients and liquids passively and actively diffused over a large surface area from the external aqueous medium into the internal intracellular aqueous medium. As evolution proceeded on, the volume of the organism increased, therefore the surface area increased, but not as great as compared to volume increase. This process of volume to surface area ration finally reached a point where specialized body components were needed inorder to maintain digestion and respiration properly. These specialized body components are invaginations and evaginations of the respiratory and digestive system endodermal lining.

It is very important to have a large surface area in the respiratory system, inorder for gas exchange to take place properly. The respiratory system increased its surface area by developing an abundant number of ducts called alveolar ducts. The walls of these ducts has numerous outpocketings or bubbles called the alveolus. The primary site of gas exchange occurs in these outpocketings or alveolus. (etc.)

Rudy, Essay 8 (portion)

A hormone may have more than one target cell and thus regulate more than one kind of activity. Digestive hormones are good examples that act upon more than one target cell and thus regulating more than one kind of activity. These digestive hormones are found to originate particularly in the stomach and the small intestine epithelial lining.

In the stomach lining, there are submucosal glands which contain certain endocrine cells. These endocrine cells are called argentaffin cells and they secrete the hormone gastrin. Gastrin is dumped into the blood immediately after secretion and it travels through the bloodstream toward its specific target organs. Gastrin can stimulate the parietal cells that are found in the stomach lining. Following stimulation, these parietal cells start to synthesize inactive enzymes such as pepsinogen and renninozin. These enzymes will become active when they come into contact with hydrochloric acid in the lumen of the stomach. Gastrin not only can stimulate parietal cells of the stomach, but it can also stimulate the pancreas ocini cells to release sodium bicarbonate into the duodenum of the small intestine. Sodium bicarbonate can act as a buffer in the small intestine by neutralizing the hydrochloric acid which is contained in the partly undigested food that comes immediately from the stomach.

There are also digestive hormones that originates from the intestinal epithelium of the small intestine and can act upon more than one target cell and thus regulate more than one kind of activity. These digestive hormones are secreted by the mucosal glands of the small (etc.)

Rudy, Essay 10 (portion)

The endocrine and nervous systems can be considered a single control system. The endocrine and nervous systems are interconnected to one another and through combined functions, both systems contribute greatly to body homeostasis, integration and morphogenesis. Both systems can act concommittantly to carry out numerous vital body functions in time of stress, fright, temperature changes, growth, etc.

Inorder for the certain endocrine system to take its effect in the body, it must need nervous input or nervous stimuli. Usually the stimuli can have an internal origin or an external origin. External stimuli and internal stimuli both stimulate sensory receptors which are either located in the body periphery or in the body visceral organs. When this stimulus occurs, a nerve impulse is generated in the central nervous system which is the brain and spinal cord. The brain will manipulate the nervous impulse information and later it will conduct its own impulse toward a specific body organ which will respond specifically to the brain impulse information and later the organ will do something to meet the stimuli needs, either it will be secretion of a hormone, or contraction of a muscle fiber.

The impulse which comes from the brain will stimulate certain neurons or cell bodies. These neurons will then undergo depolarization, specifically the axon of a neuron. The neuron produces neurotransmitters such as acetylcholine and also they contain neurohormones such as norepinephrine and seratonin. Following depolarization of the neuron axon, these neurotransmitters and neurohormones are released and they travel through a synaptic cleft and attaches to the target cell (etc.)

Rudy, Essay 12 (entire)

Several body systems are involved in maintaining salt and water balance. These body systems are in turn regulated by the endocrine and nervous systems. The endocrine component which is involved in maintaining salt and water balance is the adrenal glands and the neuroendocrine component is the hypothalamus. Both components under the response to sensory stimuli, will release a specific hormone and neu-

rohormone that will take its effects primarily on the kidney. The kidney itself has a system for maintaining the osmolarity of body fluids.

Sensory receptors that are located in the walls of the internal carotid blood vessel and also the left atrium are able to monitor the serum tonicity of the blood. During an accident when there is huge amounts of blood loss, the blood pressure will decrease. The sensory receptors senses the low blood pressure and sends nervous stimuli to the hypothalamus which in turn generates a nerve impulse to the posterior pituitary. At the posterior pituitary, nervous stimuli will cause the release of the neuroendocrine hormone called vasopressin or anti-diuretic hormone. Vasopressin will then act upon the epithelial cells of the collecting ducts to reabsorb more water from the filtrated urine into the blood. As a result, blood pressure is restored to normal.

A specific hormone that is produced in the adrenal cortex and is called aldosterone will also regulate salt and water reabsorption in the kidney. Aldosterone will stimulate the epithelial cells of the distal convoluted tubule to reabsorb sodium. When this occurs, the interstitium will become highly concentrated and will cause the water from the urine to passively diffuse into the interstitium (bloodstream).

Another system that involves water-salt balance is the renninangiotensin system. When a hemmorage occurs, extreme blood loss will occur also, this leads to a decrease blood pressure. Certain kidney cells called the juxtaglomerular cells monitors the blood pressure of the blood. When the blood pressure is decreased, these cells will secrete a specific enzyme called rennin into the blood. Rennin will then activate a precursor hormone called "angiotensinogin" (produced in the liver) to angiotensin. Angiotensin can then act as a vasoconstrictor. When the blood vessels become constricted, this causes a decrease in hydrostatic pressure in the arterioles of the kidney nephron. As a result to decrease hydrostatic pressure, sodium and water will move from the filtrate and back into the arterioles, thus restoring serum blood pressure.

The systems that are involved in salt and water balance deals entirely on the concept of osmolarity in the blood. Changes in blood pressure triggers the release of specific hormones that can act upon the tubular epithelial lining of the kidney to reabsorb sodium and water in order to restore blood pressure and body fluid balance. The nervous and endocrine systems plays an important role by regulating the salt and water reabsorption function of the kidney.

APPENDIX C

Passage/Analysis 4: Richard, March 2 (early sample)

Passage 4

(1) The digestive system has immune system components. (2) It involves both the specific and non-specific immune response. (3) The difference between the two types of response is that the non-specific response reacts against any foreign molecule and prior exposure to the foreign molecule is not needed for the defense mechanism to work. (4) The specific immune response on the other hand requires a previous exposure to the foreign molecule and specific sites on the molecule must be recognized for this defense system to work.

(5) The non-specific immune response of the digestive system involves three major types of barriers: physical, chemical, and ecological barriers. (6) Physical barriers involve the lining of the digestive tract, from the mouth to anus, which is an endothelial lining derived from endoderm. (7) The cells of endothelial lining vary depending on location and function in the digestive tract, but they all serve in keeping undersirable foreign particles out of the body.

Analysis 4

	No. of types and strands	No. of predications		
1.	lead-in			The digestive system has immune system components.
2.	2	3	a. Strand 2	The specific response is involved
			b. Strand 2	The non-specific response is involved
			c. Relational	Sentence 2a COMPARE Sentence 2b ("both")
3.	2	6	a. Strand 2	The non-specific response reacts against any
			b. Strand 1	Prior exposure (by the body) to the foreign . . . is not needed
			c. Relational	The two types of response COMPARE ("differ")
			d. Strand 2	This defense system works
			e. Relational	Sentence 3b (not needed) for CAUSE Sentence 3d
			f. Relational	Sentences 3a, b, c, d, e SPECIFY Sentence 2
4.	2	5	a. Relational	Sentence 4b COMPARE Sentence 4c

			b. Strand 2	Specific immune response requires a previous
			c. Strand 2	Specific sites on the molecule must be recog . . .
			d. Relational	Sentence 4c CAUSE Sentence 4e
			e. Strand 2	This defense system works
5.	2	2	a. Relational	Sentence 5b SPECIFY Sentence 2
			b. Strand 1	The non-specific immune response is three . . .
6.	2	3	a. Relational	Sentence 6b SPECIFY Sentence 5
			b. Strand 1	The barrier (is) the lining of the digestive
			c. Strand 1	This is an endothelial lining derived from
7.	3	6	a. Relational	The cells of endothelial lining COMPARE ("vary")
			b. Relational	Sentence 7c CAUSE Sentence 7a
			c. Strand 1	(The cells have) location and function in the . . .
			d. Relational	Sentence 7a COMPARE Sentence 7c
			e. Relational	Sentence 7f GENERALIZE
			f. Strand 2	They keep undesirable foreign particles out . . .

Number of sentences with relational information: 6 out of 6, 100%.
Number of relational predications per sentence: 2.00.
Average number of predications per sentence: 4.16.

Passage/Analysis 5: Richard, April 27 (later sample)

Passage 5

(1) Several body systems are involved in maintaining salt and water balance. (2) They include the digestive system, the urinary system, and the skin's secretory system. (3) All of these systems involve the secretion of sodium ions since sodium is the major determining ion that causes water to flow across cell membranes. (4) If sodium salts are secreted, water follows. (5) That is the law of osmotic transport.

Analysis 5

	No. of types and strands	No. of predications		
1.	lead-in			Several body systems are involved in maintaining . . .
2.	2	3	a. Relational	Sentence 2b SPECIFY Sentence 1
			b. Strand 1	They are the digestive system, the urinary . . .
			c. Strand 1	The skin has a secretory system
3.	2	5	a. Relational	Sentence 3b GENERALIZE Sentence 2
			b. Strand 2	They involve secretion of sodium ions

			c. Relational	Sentence 3d CAUSE Sentence 3b
			d. Relational	Sodium CAUSE Sentence 3e
			e. Strand 2	Water flows across cell membranes
4.	2	3	a. Relational	Sentence 4b CAUSE Sentence 4c
			b. Strand 2	Sodium salts are secreted
			c. Strand 2	Water follows
5.	2	2	a. Relational	Sentence 5b GENERALIZE Sentence 5a
			b. Strand 1	This is the law of osmotic transport

Number of sentences with relational information: 4 out of 4, 100%.
Number of relational predications: 6 in 4 sentences, or 1.50 per sentence.
Average number of predications per sentence: 3.70.

Passage/Analysis 6: Carol, March 2 (early sample)

Passage 6

(1) The digestive system has immune system components. (2) This is because it is considered an external surface in the tube within a tube body plan and is the first thing an invading substance will come in contact with. (3) The primary line of defense or first component of the immune system an invader would meet would be physical or chemical barriers. (4) Some examples of physical barriers would be that all the epithelium of mucus layer of the digestive system has tight junctions which allows nothing to enter intercellularly only through the epithelial cell, and the outermost epithelial cells are cornified.

(5) Another physical barrier is that among the epithelial cells there are cells which secrete mucus that traps the invaders with this sticky substance while the ciliated epithelia cell move the bacteria out to be swallowed and digested or secreted.

(6) Some examples of chemical barriers are the varying pH in different parts of the digestive system.

Analysis 6

	No. of types and strands	No. of predications		
1.	lead-in			The digestive system has immune system components.
2.	3	4	a. Relational	Sentence 2b, c CAUSE Sentence 1
			b. Strand 1	It is an external surface in the tube within . . .
			c. Strand 2	An invading substance will come in contact . . .
			d. Relational	(The digestive system) COMPARE ("is first")
3.	2	4	a. Strand 1	The immune system has a line of defense and . . .

			b. Relational	Sentence 3d COMPARE ("primary" or "first")
			c. Relational	Sentence 3d SPECIFY Sentence 1
			d. Strand 1	(there are) physical or chemical barriers
4.	3	5	a. Relational	Sentence 4b SPECIFY Sentence 3d
			b. Strand 1	All the epithelium . . . has tight junctions
			c. Relational	Sentence 4b (NP) CAUSE 4d
			d. Strand 2	Nothing enter intercellularly, only through . . .
			e. Strand 1	The outermost epithelial cells are cornified . . .
5.	3	8	a. Relational	Sentence 5b SPECIFY Sentence 3d
			b. Strand 1	There are cells among the epithelial cells
			c. Strand 2	The cells secrete mucus
			d. Strand 2	The mucus traps the invaders with this sticky . . .
			e. Relational	Sentence 5c, d COMPARE Sentence 5e, f
			f. Strand 2	The ciliated epithelia cell move the bacteria . . .
			g. Relational	Sentence 5e CAUSE 5g
			h. Strand 2	Bacteria are swallowed and digested or . . .
6.	2	2	a. Relational	Sentence 6 SPECIFY Sentence 3NP
			b. Strand 1	pH (is in) different parts of the digestive . . .

Number of sentences with relational information: 5 out of 5, 100%.
Nur ber of relational predications per sentence: 2.20
Average number of predications per sentence: 4.60.

Passage/Analysis 7: Carol, April 27 (later sample)

Passage 7

(1) Several body systems are involved in maintaining salt and water balance. (2) This balance is necessary in maintaining homeostasis, a necessary condition for survival. (3) Probably the main system with which all the other body systems help to accomplish this balance is the urinary system. (4) The main organ of this system is the kidney which is made up of precisely arranged nephrons and a collecting system specialized to maintain salt and water balance around a set point. (5) A quarter of the cardiac output is filtered through the glomerulus of the kidney which is situated in Bowman's capsule.

Analysis 7

	No. of types and strands	No. of predications		
1.	lead-in			Several body systems are involved in maintaining . . .
2.	3	3	a. Relational	This balance CAUSE Sentence 2b

			b. Strand 2	Homeostasis is maintained
			c. Strand 1	Homeostasis is a necessary condition for . . .
3.	2	3	a. Relational	The system COMPARE other systems ("the main system")
			b. Relational	The urinary system SPECIFY system
			c. Strand 2	All the body systems help to accomplish this
4.	3	5	a. Relational	The organ COMPARE other organs ("the main organ")
			b. Relational	The kidney SPECIFY organ
			c. Strand 1	The kidney is made up of precisely arranged . . .
			d. Strand 2	The collecting system maintains salt and . . .
			e. Relational	Sentence 4d SPECIFY Sentence 3
5.	2	2	a. Strand 2	A quarter of the cardiac output is filtered . . .
			b. Strand 1	The kidney is situated in Bowman's capsule

Number of sentences with relational information: 3 out of 4, 75%.
Number of relational predications per sentence: 1.50.
Average number of predications per sentence: 3.25.

Passage/Analysis 8: Rudy, February 16 (first early sample)

Passage 8

(1) Smooth muscle action affects cardiac output. (2) Smooth muscle is primarily found in the lining of the heart and blood vessels. (3) The smooth muscle which affects cardiac output the greatest is found in the lining of the heart. (4) Smooth muscle which is found in the lining of blood vessels also effects cardiac output but to a lesser extent than cardiac smooth muscle. (5) Cardiac output is the amount of blood that leaves the left ventricle of the heart in a certain amount of time. (6) The cardiac output of humans is normally about five litres per minute. (7) Besides the effect of smooth muscle upon cardiac output there are other facts which can also vary the rate of cardiac output. (8) The cardiac cycle consists of four phases. (9) The action of smooth muscle on the physical activity of smooth muscle effects all four phases. (10) However, the phase of the cardiac cycle in which the action of smooth muscle effects the most is during the early portion of the systolic phase. (11) That early portion of the systolic phase is known as the isovolumnic contraction period. (12) During this period, the ventricles of the heart are filled with a certain amount of blood.

Analysis 8

	No. of types and strands	No. of predications		
1.	lead-in			Smooth muscle action affects cardiac output.
2.	1	1	a. Strand 1	Smooth muscle is primarily found in the . . .
3.	2	2	a. Relational	Smooth muscle COMPARE other smooth muscle ("the greatest")
			b. Strand 1	Smooth muscle is found in the lining of the . . .
4.	3	5	a. Strand 1	Smooth muscle is found in the lining of . . .
			b. Relational	Sentence 4a COMPARE other smooth muscle ("also")
			c. Strand 2	Sentence 4a effects cardiac output
			d. Relational	Sentence 4c COMPARE Sentence 4e ("to a lesser extent")
			e. Strand 2	Cardiac smooth muscle effects cardiac output
5.	1	1	a. Strand 1	Cardiac output is the amount of blood that leaves the left ventricle of the heart.
6.	1	1	a. Strand 1	The cardiac output of humans is normally . . .
7.	2	3	a. Relational	Factors COMPARE the effect of smooth muscle . . .
			b. Relational	Factor CAUSE Sentence 7c
			c. Strand 2	The rate of cardiac output varies
8.	1	1	a. Strand 1	The cardiac cycle consists of four phases
9.	1	1	a. Strand 2	All four phases affected by the action of smooth muscle or the physical activity of smooth muscle

Number of sentences with relational information: 3 out of 8, or 37%.
Number of relational predications per sentence: .62.
Average number of predications per sentence: 1.87.

Passage/Analysis 9: Rudy, March 2 (second early sample)

Passage 9

(1) The digestive system has immune system components. (2) These immune system components are found in the walls of the alimentary canal. (3) The walls of the digestive system consist of four distinct layers. (4) The four layers are mucosa, submucosa, muscularis externa, and adventitia or serosa. (5) Primarily, the immune system components are found only in the mucosa, and submucosa layers.

(6) The mucosa layer of the digestive tract is comprised of three layers. (7) The mucosa layer is the innermost layer of the four distinct layers. (8) It is the layer that is closest to the lumen of the digestive tract. (9) The three layers which constitute the mucosa layer are, epithelia cell layer (innermost), lamina propria (middle), and muscularis mucosae (outermost, adjacent to the submucosa).

Analysis 9

	No. of types and strands	No. of predications		
1.	lead-in			The digestive system has immune system components.
2.	1	1	a. Strand 1	These immune system components are found in . . .
3.	1	1	a. Strand 1	The walls of the digestive system consist . . .
4.	1	1	a. Strand 1	The four layers are mucosa, submucosa . . .
5.	1	1	a. Strand 1	Primarily, the immune system components are . . .
6.	1	1	a. Strand 1	The mucosa layer of the digestive tract is . . .
7.	1	1	a. Strand 1	The mucosa layer is the innermost layer of . . .
8.	2	2	a. Strand 1 b. Relational	The layer is close to the lumen It COMPARE other layers
9.	1	2	a. Strand 1 b. Strand 1	The three layers are epithelia cell layer, . . . The layers constitute the mucosa layer

Number of sentences with relational information: 1 out of 8, or 12%.
Number of relational predications per sentence: .12.
Average number of predications per sentence: 1.25.

Passage/Analysis 10: Rudy, April 27 (later sample)

Passage 10

(1)Several body systems are involved in maintaining salt and water balance. (2) These body systems are in turn regulated by the endocrine and nervous systems. (3) The endocrine components which is involved in maintaining salt and water balance is the adrenal glands, and the neuroendocrine component is the hypothalamus. (4) Both components under the response to sensory stimuli, will release a specific hormone and neurohormone that will take its effects primarily on the kidney. (5) The kidney itself has a system for maintaining the osmolarity of body fluid.

(6) Sensory receptors that are located in the walls of the internal carotid blood vessel and also the left atrium are able to monitor the serum tonicity of the blood. (7) During an accident where there is huge amounts of blood loss, the blood pressure will decrease.

Analysis 10

	No. of types and strands	No. of predications		
1.	lead-in			Several body systems are involved in maintaining . . .
2.	2	2	a. Strand 2	These systems are regulated by the endocrine . . .
3A.	2	2	a. Strand 2 b. Relational	The endocrine components is involved in . . . Adrenal glands SPECIFY components involved in . . .
3B.	2	2	a. Strand 2 b. Relational	The neuroendocrine components is involved in The hypothalamus SPECIFY neuroendocrine components . . .
4.	2	5	a. Relational b. Strand 2 c. Relational d. Strand 2 e. Strand 2	Components COMPARE ("both") Components respond to sensory stimuli Sentence 4b CAUSE Sentence 4e Components release a specific hormone and . . . This will take its effect primarily on the
5.	3	3	a. Relational b. Strand 1 c. Strand 2	The kidney COMPARE other systems ("itself") The kidney has a system The system maintains the osmolarity of body
6.	3	3	a. Relational	Sentences 6b, c SPECIFY Sentence 5

			b. Strand 2	Sensory receptors monitor the serum tonicity . . .
			c. Strand 1	Sensory receptors are located in the walls of . . .
7.	2	3	a. Relational	Sentence 7b CAUSE Sentence 7c
			b. Strand 2	Huge amounts of blood are lost in an accident
			c. Strand 2	The blood pressure decreases

Number of sentences with relational information: 7 out of 7, or 100%.
Number of relational predications per sentence: 1.14.
Average number of predications per sentence: 2.86.

*Independent clauses are counted as sentences.

Passage/Analysis 11: Tomas, March 2 (early sample)

Passage 11

(1) The digestive system has immune system components. (2) It is the immune system of the digestive system which allows the organism to combat foreign molecules that happen to enter the body. (3) These foreign molecules are taken care of by the macrophages, lymphocytes and other phagocytic cells of the body.

(4) Before we discuss the immune system of the digestive system, it is only proper to recognize that the digestive system has four tissue layers. (5) It is within the tissue layers that you would be able to find the immune system components.

(6) The lumen of the digestive system is the cavity where food is digested and later absorbed into the cells. (7) The first layer of tissues surrounding the lumen is called the mucosa. (8) It is here in the mucosa where you find the immune system of the digestive system.

(9) The mucosa is lined with epithelium. (10) The epithelium is usually classified as simple columnar epithelium. (11) Internal from the epithelium you will expect to find the lamina propria.

Analysis 11

	No. of types and strands	No. of predications		
1.	lead-in			The digestive system has immune system components.
2.	2	3	a. Relational	The immune system CAUSE Sentence 2b
			b. Strand 2	The organism combats foreign molecules
			c. Strand 2	The molecules enter the body
3.	2	3	a. Strand 2	The macrophages, etc. of the body take care . . .
			b. Relational	Sentence 3a SPECIFY Sentence 3b
			c. Relational	Macrophages, etc. SPECIFY phagocytic cells

4.	1	1	a. Strand 1	The digestive system has four tissue layers
5.	1	1	a. Strand 1	The immune system components are located . . .
6.	2	2	a. Strand 1 b. Strand 1	The lumen of the digestive system is the cavity Food is digested and later absorbed . . .
7.	1	1	a. Strand 1	The first layer of tissues surrounding the lumen is called . . .
8.	1	1	a. Strand 1	The immune system of the digestive system is located . . .
9.	1	1	a. Strand 1	The mucosa is lined with epithelium
10.	1	1	a. Strand 1	The epithelium is usually classified as simple . . .
11.	1	1	a. Strand 1	The lamina propria is internal from the . . .

Number of sentences with relational predications: 2 out of 10, 20%.
Number of relational predications per sentence: .30.
Average number of predications per sentence: 1.50.

Passage/Analysis 12: Tomas, April 27 (later sample)

Passage 12

(1) The retention of excess salt and water in the extracellular spaces is like drowning the cells. (2) To avoid such metabolic accident, the body removes these two substances to the outside environment so that proper water and salt level could be present around the cells. (3) A high concentration of salt around the cells will tend to create a salt gradient, whereby the sodium or chloride ions will be forced by passive diffusion to enter the cell resulting in a condition called edema. (4) This the body has to regulate so that its cellular activities, like the making of adenosine triphosphate and so forth, will not be hindered.

Analysis 12

	No. of types and strands	No. of predications		
1.	2	3	a. Strand 2 b. Strand 2 c. Relational	Excess salt and water is retained in the . . . The cells are drowned Sentence 1a COMPARE Sentence 1b
2.	3	4	a. Strand 2 b. Strand 1	The body removes the two substances to the (The body has no) metabolic accident

			c. Relational	Sentence 2a CAUSE Sentence 2b, 2d
			d. Strand 1	The proper salt and water balance can be . . .
3.	3	5	a. Strand 2	A high concentration of salt around the cells . . .
			b. Relational	Sentence 3a CAUSE Sentence 3c
			c. Strand 2	Sodium or chloride ions forced by passive . . .
			d. Relational	Sentence 3c CAUSE Sentence 3e
			e. Strand 1	(There is a) condition called edema
4.	2	5	a. Strand 2	The body regulates this
			b. Relational	Sentence 4a CAUSE Sentence 4c
			c. Strand 2	Cellular activities will not be hindered
			d. Strand 2	ATP is made
			e. Relational	Sentence 4d SPECIFY NP in Sentence 4c

Number of sentences with relational information: 4 out of 4, or 100%.
Number of relational predications per sentence: 1.50.
Average number of predications per sentence: 4.25.

Passage/Analysis 13: Tua, March 2 (early sample)

Passage 13

(1) The digestive system has immune systems components. (2) These components are nonspecific and specific immune responses. (3) The nonspecific immune responses includes the inflammatory response and the interferance. (4) The inflammatory response usually refers to a disruption of the metabolism when any microbes enters the body. (5) This disruption of the metabolism by microbes lead to tissue damaging, which then activates the most cells to release histamine as well as altering the vascular surface of the blood vessels. (6) As a result of histamine being released, it increases the vasodilation and permeability to food substances or proteins. (7) Also, at the same time, the resistance of the blood vessels has decreased. (8) Therefore, it enhances the flow of blood to various parts of the body much more efficiently.

Analysis 13

	No. of types and strands	No. of predications		
1.	lead-in			The digestive system has immune system components.
2.	2	2	a. Relational	Sentence 2b SPECIFY Sentence 1
			b. Strand 1	These components are nonspecific and specific . . .
3.	2	2	a. Relational	Sentence 3b SPECIFY Sentence 2
			b. Strand 1	The nonspecific immune responses includes the . . .

4.	3	5	a. Relational	Sentence 4b SPECIFY Sentence 3
			b. Strand 1	The inflammatory response usually refers to Sentences 4c, d, e
			c. Strand 2	Microbes enter the body
			d. Strand 2	The metabolism is disrupted
			e. Relational	Sentence 4c CAUSE Sentence 4d
5.	2	5	a. Relational	Sentence 4d CAUSE Sentence 5b
			b. Strand 2	Tissues are damaged
			c. Relational	Sentence 5b CAUSE Sentences 5d, e
			d. Strand 2	The cells release histamine
			e. Strand 2	The vascular surface of the blood vessels . . .
6.	2	4	a. Strand 2	Histamine is released
			b. Relational	Sentence 5a CAUSE Sentence 5c, d
			c. Strand 2	Vasodilation increases
			d. Strand 2	Permeability to food substances or proteins . . .
7.	1	2	a. Strand 2	The resistance of the blood vessels has dec . . .
8.	2	3	a. Relational	Sentence 7b CAUSE Sentence 8b, c
			b. Strand 2	The blood flows
			c. Relational	Sentence 8b COMPARE (other blood flow)

Number of sentences with relational information: 6 out of 7, 86%.
Number of relational predications per sentence: 1.28.
Average number of predications per sentence: 3.14.

Passage/Analysis 14: Tua, April 27 (later sample)

Passage 14

(1) Several body systems are involved in maintaining salt and water balance. (2) One of the most important system is the urinary system. (3) The urinary systems primarily control the balancing of the salt and water processes. (4) The maintaining of these processes is done in three ways. (5) The first one is the reabsorption of sodium. (6) This is an active process, which involves a carrier (unclear) and it requires an energy supply and it can occur against the electrochemical gradient. (7) The second process is the reabsorption of chloride by means of passive diffusion. (8) This depends upon the active reabsorption of sodium.

Analysis 14

	No. of types and strands	No. of predications		
1.	lead-in			Several body systems are involved in maintaining . . .
2.	2	2	a. Strand 1 b. Relational	One important system is the urinary system (It) COMPARE (other systems)
3.	2	2	a. Strand 2 b. Relational	The urinary system primarily controls the . . . Sentence 3a SPECIFY Sentence 2
4.	2	2	a. Strand 2 b. Relational	The maintaining of these processes is done in . . . Sentence 4 SPECIFY Sentence 3
5.	2	2	a. Strand 2 b. Relational	Sodium is reabsorbed Sentence 5 SPECIFY Sentence 4
6A.	2	3	a. Strand 1 b. Strand 2 c. Relational	This is an active process (It) involves a carrier (unclear) Sentence 6A SPECIFY Sentence 5
6B.	2	2	a. Strand 1 b. Relational	It requires an energy supply Sentence 6B SPECIFY Sentence 5
6C.	2	2	a. Strand 2 b. Relational	It can occur against the electrochemical . . . Sentence 6C SPECIFY Sentence 5
7.	2	4	a. Strand 2 b. Relational c. Strand 2 d. Relational	Chloride is reabsorbed Sentence 7c CAUSE Sentence 7a (Chloride) diffuses passively Sentence 7a SPECIFY Sentence 4
8.	2	2	a. Relational b. Strand 2	Sentence 8b CAUSE Sentence 7 Sodium is reabsorbed actively

Number of sentences with relational predications: 7 out of 7, or 100%.
Number of relational predications per sentence: 1.43.
Average number of predications per sentence: 3.00.

*Independent clauses are counted as sentences.

Passage/Analysis 15: Jose, April 27 (later sample)
(See Chapter 5 for earlier sample.)

Passage 15

(1) Several body systems are involved in maintaining salt and water balance. (2) Water and salt have to be balanced so that the systems as well as the entire body can function properly. (3) The body stores its water and salt. (4) These two can be produced by the food that we eat and by other processes going on in the body. (5) The food that we eat of course go through several processes in the digestive system. (6) The glands' secretions are mostly water. (7) They are secreted into the digestive tract to mix with the food or to balance out the fluid in this tract. (8) The intestines are the sites for minerals and H_2O absorption. (9) These minerals and water get into the blood where they are influenced by hormones.

Analysis 15

	No. of types and strands	No. of predications		
1.	lead-in			Several body systems are involved in maintaining . . .
2.	2	3	a. Strand 2	Water and salt have to be balanced
			b. Strand 2	The systems as well as the entire body can . . .
			c. Relational	Sentence 2a CAUSE Sentence 2c
3.	1	1	a. Strand 2	The body stores its water and salt
4.	2	4	a. Strand 2	We eat food
			b. Strand 2	Other processes go on in the body
			c. Relational	Sentences 4a, b CAUSE Sentence 4d
			d. Strand 2	These two are produced
5.	1	1	a. Strand 2	The food that we eat of course go through . . .
6.	1	2	a. Strand 2	The glands secrete
			b. Relational	Sentence 6a are mostly water
7.	2	4	a. Strand 2	They are secreted into the digestive tract
			b. Relational	Sentence 7a CAUSE 7c, d
			c. Strand 2	They mix with the food
			d. Strand 2	They balance out the fluid in this tract
8.	2	2	a. Strand 1	The intestines are the sites
			b. Strand 2	Minerals and water are absorbed
9.	1	2	a. Strand 2	These minerals and water get into the blood
			b. Strand 2	They are influenced by hormones

Number of sentences with relational information: 3 out of 8, 37%.
Number of relational predications per sentence: .37.
Average number of predications per sentence: 2.37.

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